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A NEW
MANUAL ON POISONS.

LONDON

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NEW-STREET SQUARE

COLORED REACTIONS OF CHEMICAL TESTS

Referred to in the preceding pages.

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CHECKED.

THE
TOXICOLOGIST'S GUIDE:
A NEW MANUAL ON POISONS

GIVING THE BEST METHODS OF MANIPULATION TO BE PURSUED FOR
THEIR DETECTION (POST MORTEM OR OTHERWISE).

2730

BY

JOHN HORSLEY, F.C.S. SOCIETY

ANALYTICAL CHEMIST, CHELTENHAM.

ILLUSTRATED BY COLOURED AND OTHER DIAGRAMS.



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P R E F A C E.

As the question of the *existence of poison* is a matter of serious importance in any *suspected or disputed case*, such a grave responsibility rests upon the individual to whom the subject is referred, that it behoves him, both for his own credit's sake as well as for the interests of society, and more especially those who may be accused, to be *clear and specific* in his mode of procedure, so as to make the evidence founded thereon as conclusive as possible.

Under this impression the following Manual or System has been drawn up, embracing a rigid *step by step* search for every kind of poison in cases where none in particular is indicated. Should, however, the symptoms and other circumstances *suggest* the poison, the case will be the more simplified. Many of the processes and tests mentioned are quite new, but will be found very

striking and reliable, the Author having purposely excluded any which would involve the *least ambiguity*; and by publication in this concise form he trusts the Manual will be appreciated by the profession, as reference to larger works, in cases of emergency, is often attended with inconvenience if not *disappointment*.

Besides the figures of apparatus, microscopic appearance of salts, &c., a *coloured plate* of the various chemical reactions has been added, which it is hoped will tend to strengthen the operator's confidence in the results of his examination.

COUNTY ANALYST'S LABORATORY,
POLICE-STATION, CHELTENHAM :
Jan. 1, 1866.

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PRELIMINARY OBSERVATIONS.

FORMERLY it was the practice to confine an analysis to *the stomach and its contents*; experience has, however, shown that *most, if not all the viscera*, including the bladder and urine, are required before anything like a satisfactory conclusion can be drawn as to the existence of poison.

The stomach, with its contents, should always be received by the analyst in its *entire state*, and not, as is sometimes the case, *slit up* and the contents mixed in a jar with other fluids and organs, a practice which is highly objectionable, as it may lead to the ends of justice being defeated by the *complication* involved. A slight incision may suffice to enable a person to judge of the state of the organ and the nature of its contents, when it should be tied up and handed to the analyst.

Sometimes in case of accident or dispute it may be necessary to preserve a portion (say one third) of the stomach and other organs, together with any fluids or solids in bottles or otherwise, for *further reference and confirmation*; but they should be all properly labelled and dated, and kept in a *cool place underground*.

At the same time that the analyst is furnished with the necessary organs, it would be as well to make him acquainted with the *history of the case*, including the

symptoms and effects, as in all probability it may *aid* him in his search, and tend to an economical use of the various organs and substances to be operated on, which would otherwise soon be exhausted for want of a more definite course of proceeding.

In conducting a post-mortem analysis it would be desirable, where practicable, that some idea of the *quantity* of poison found be supplied, although it is not absolutely necessary for the purpose, so long as the particular poison be *clearly identified* by the proper chemical reactions corresponding to such substance, and the same is satisfactorily supported by the medical and physiological evidence. But in some cases, even with the *greatest care* observed, the chemical evidence *may entirely fail*, notwithstanding that death has resulted from poison, which may have been either all decomposed or eliminated from the system during life. Frequent cases have been known where a *peculiar redness* of the stomach has been ascribed to the effects of an irritant poison, but the most diligent search failed to detect any. On the other hand, mineral poisons, as antimony, arsenic, &c., have been readily detected in the urine and fæces *before death*, but *none* in the body *afterwards*.

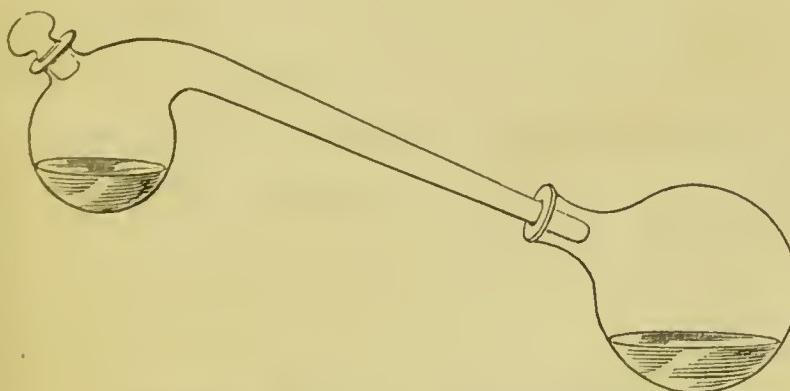
Whatever may be the result of the chemical investigation, the utmost secrecy should be observed previous to the coroner's inquisition, lest its publication should operate prejudicially.

THE
TOXICOLOGIST'S GUIDE.

EXAMINATION OF THE CONTENTS OF THE
STOMACH FOR 'UNABSORBED POISON.'

1. On opening the stomach observe if there be any smell of laudanum or opium.
2. Observe if there be any smell of volatile poisons, such as alcohol, ether, chloroform, prussic acid, oil of bitter almonds, tobacco, &c.
3. Ascertain the character of the contents, whether animal or vegetable matter, farinaceous, or otherwise.
4. Note their bulk or weight.
5. If any smell of volatile poison exists (when practicable), a distillation must be made with a portion A, and the product of the receiver examined.

Fig. 1.



Distilling apparatus for volatile poisons.

icable), a distillation must be made with a portion A, and the product of the receiver examined.

It is not every volatile poison which will admit of this treatment—*nicotina* and *conia* for instance; these, however, are seldom had recourse to for criminal purposes. A process for extracting them by means of *ether* will be mentioned under the head of *Alkaloids*.

ALCOHOL.

The *odour* having been detected, the contents or part thereof should be mixed with a little water, and if *acid* to test paper, the liquid should be *neutralised* with *carbonate of potash* before distillation, the receiver being kept constantly cooled, and about one-third driven over.

Tests.—1. Dip a glass rod into the distilled liquor, and see if it be *inflammable*; if so,

2. Mix a small portion with diluted *sulphuric* or *hydrochloric acid*, adding a drop or so of a solution of *bichromate of potash*. On the application of *heat* to the mixture, if it turns green (No. 1, in coloured plate), giving off the peculiar odour of ‘*aldehyde*,’ then *alcohol* is present.

The whole of the *alcohol* may now, after mixing some dry *carbonate of potash* with the rest of the contents of the stomach diluted with water, be distilled over, and the amount noted, preserving it for exhibition.

Alcohol has been obtained by operating on the brain in cases where the stomach yielded none.

ETHER.

This, like *alcohol*, when it has been taken in the liquid form (but not in vapour), may be distilled from the contents of the stomach.

There are no particular *tests* for it beyond its peculiar penetrating odour, and its property of floating on water.

CHLOROFORM,

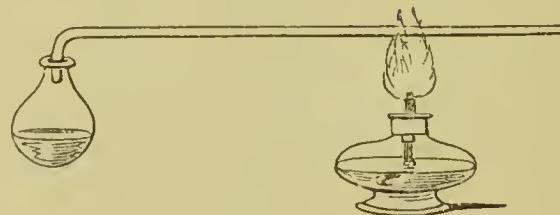
If it exist in any quantity, may also be distilled off; but it is very *questionable* whether the operation will be attended with success, although its odour may be detected, for it is of such a volatile nature that little or none may be obtained.

Ragsky has propounded a *test* based on the fact of *chloroform* being decomposed into *carbon*, *hydrochloric acid*, and *chlorine*; thus,—

The blood is put into a flask with a long tube, which is connected with a piece of paper coated with *starch* and *iodide of potassium*. On *boiling*, the *chloroform* is volatilised, and *heat* being then applied to the tube, sets free the *chlorine*, which reacts on the prepared paper, producing a blue colour (No. 2, coloured plate), and is said to detect $\frac{1}{100000}$ part of *chloroform* present; but

Dr. Taylor and others who have put it into practice, were not successful in obtaining the evidence promised. The late Dr. Snow improved on this process by driving over the acid gases into a solution of nitrate of silver, and is said to have succeeded in detecting the chlorine from the amputated limb of a person operated on under the influence of *chloroform*. The chlorine of the natural chlorides of the body would not interfere, since it would not be evolved at the temperature of the water-bath or

Fig. 2.



sand-bath used to boil the liquid containing the organic matters.

PRUSSIC ACID.

If this be present we must proceed quickly, as it is very likely to escape owing to its great volatility.

If the odour of *bitter almonds* or *prussic acid* is well marked, and the fluid be *already acid*, a simple distillation into a receiver containing a little distilled water *may suffice* for its elimination ; on the other hand, if the fluid be *alkaline*, from *cyanide of potassium* having been used, it must be first *slightly acidified* with *sulphuric acid*, then placed in a stoppered retort with a receiver attached containing a little pure water, and distilled by a water-bath, the receiver being kept surrounded with *ice-cold water*. When one-eighth has been driven over the distillation is stopped.

Tests.—1. Having recognised its smell, to a portion of the distilled product add a drop or so of a solution of *nitrate of silver*, when a *white curdy precipitate* of '*cyanide of silver*' is formed, which is insoluble in cold dilute *nitric acid*, but readily soluble in *aqua ammoniae*, and in *cyanide of potassium*.

This test will show the $\frac{1}{96000}$ of a grain of real or anhydrous *prussic acid* in solution. (Horsley.)

Cyanide of potassium is extensively used in photography and gilding, and, from its being easily obtained, has frequently been used as a poison. It is so powerful that $2\frac{1}{2}$ grains are equal to fifty drops of *medicinal prussic acid*.

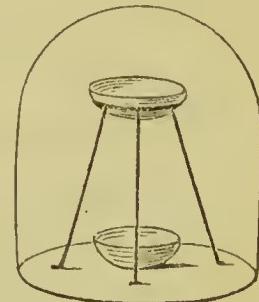
2. To another portion of the distilled liquor in a

test tube, add a little *liquor potassæ*, then a drop or so of a solution of *sulphate of iron*, followed by a little *perchloride of iron* (tinct. ferr. mur.); an insoluble Prussian blue precipitate (No. 3, coloured plate) forms on the *addition of some free hydrochloric acid*, the blue colour being afterwards readily discharged by *any alkali*, and turned of a dirty brown, which is conclusive of the existence of *prussic acid*.

3. To another portion of the distillate add a few drops of *yellow sulphide of ammonium*, and evaporate by a gentle heat to *dryness*, so as to form a '*sulphocyanide*.' Dissolve this in a little water and test with *perchloride of iron*, when a blood-red solution (No. 15) is obtained, the colour being readily discharged or destroyed by *bichloride of mercury*, which distinguishes it from the similar colour afforded by the *meconic acid* of opium hereafter to be mentioned.

4. A modification of No. 3 may be performed on a small scale *without distillation* by placing a part of the suspected fluid contents of the stomach, previously acidified with *sulphuric acid*, in a watch-glass, and a little above that arranging another watch-glass holding a few drops of *sulphide of ammonium*, and covering all with a glass dome, as in fig. 3. In about twenty minutes or so this upper glass may be removed, and the contents dried over a water-bath, when it is fit for applying the *perchloride of iron* as previously stated. This is called Liebig's test, and is due to the *nascent cyanogen*, liberated by the *sulphuric acid*, com-

Fig. 3.



bining with the *sulphide of ammonium* in the upper watch-glass to form the '*sulphocyanide*.'

5. Another modification of the nascent test may be made by substituting a little strong solution of *nitrate of silver* in the *upper watch-glass* for one containing the *sulphide of ammonium*, when a *white film* of '*cyanide of silver*' is obtained. The dried *cyanide of silver* strongly heated in a glass tube evolves the *cyanogen*, which will burn of a *rose or purple colour* on a light being applied.

A quantitative experiment should now be made by precipitating the remainder of the distillate with *nitrate of silver* as '*cyanide of silver*', well washing it with water whilst on the filter, and drying over a water-bath.

Every 5 grains of dried *cyanide of silver* contains 1·00 (or 1 grain) of *anhydrous prussic acid*, equal to 50 drops of the medicinal acid, or 20 of Scheele's strength.

Herapath says, that the *apparent disappearance* of *prussic acid* from a dead body is due to its conversion into a *sulphocyanide*, and that an evaporated *alcoholic solution* will yield the characteristic blood-red colour on being tested with *perchloride of iron*. He says he has detected it thus after two months' interment. I am *not aware* whether this has been *corroborated* by other chemists.

It must be borne in mind that the saliva, from containing *sulphocyanogen*, gives *similar* reactions with a *persalt of iron*.

What is called almond flavouring (a solution of *oil of bitter almonds*) is sometimes used as a poison. The *oil* being about four times stronger than *medicinal prussic acid*, 100 drops of it are equal to 13 grains of *anhydrous acid*, or 11 drachms (nearly $1\frac{1}{2}$ ounce) of ordinary acid. 100 grains of *bitter almond pulp* are equal to 2 of the *oil* or $\frac{1}{4}$ grain of *anhydrous acid*, or $12\frac{1}{2}$ drops of *medicinal acid*. From 15 to 30 drops of *oil of bitter almonds* have proved fatal. See the article *Nitrobenzole*, post.

OXALIC ACID.

If the contents of the stomach are strongly acid, we may proceed to search for any *crystals* of this acid with another portion (B), as follows :—

Having boiled the contents with distilled water, filter through a cloth : precipitate the acid by the addition of an excess of *acetate of lead*, collect the precipitated *oxalate of lead*, and having well washed it, suspend it in a tall cylindrical vessel of distilled water, and pass a stream of *sulphuretted hydrogen* through it until all the lead is converted into a *black sulphide*, and the liquor smells strongly ; filter, and evaporate the clear liquor to dryness to obtain the *oxalic acid*.

Or, instead of using *sulphuretted hydrogen gas*, the precipitate of *oxalate of lead* may be agitated with water containing a solution of *sulphide of ammonium*, and when the decomposition is complete, which may be known by the disappearance of all *white* particles in the precipitate, the liquid should be filtered and carefully evaporated to dryness so as to obtain the *oxalic acid* in the form of '*oxalate of ammonia*,' when it is fit for solution and testing.

Tests.—1. A solution of *oxalic acid* or any of its alkaline salts produces with *salts of lime* a white precipitate (No. 5, coloured plate), which is recognised by its *insolubility in acetic acid*, though soluble in strong mineral acids, as *nitric* and *hydrochloric acids*. *Oxalate of lime* is also *insoluble* in an excess of *oxalic acid solution*.

2. A solution of *oxalic acid* reduces the *salts of gold* to a *metallic state* (becoming a spangling brown powder on being *rubbbed*).

3. When *strong sulphuric acid* is poured upon *oxalic acid* or any of its salts, and the mixture *heated* in a test tube, decomposition takes place, attended with the evolution of two gases, *carbonic acid* and *carbonic oxide*: the latter burns with a *pale blue flame*, which is characteristic.

From the rapidity of its absorption into the system, *oxalic acid* is *not always to be detected*. Orfila, Christison, Taylor, and others, being of opinion that it becomes decomposed in the organism, its extraction is very doubtful.

Every 10 grs. *oxalate of lime* (air-dried) are equal to 4.49 grs. or $4\frac{1}{2}$ grs. *oxalic acid*.

,, 10 „ *oxalate of lime* (dried at 212°) are equal to 4.93 grs. or 5 grs. *oxalic acid*.

,, 10 „ *oxalate ammonia* (dry) are equal to 5.80 grs. abt. 6 grs. *oxalic acid*.

,, 10 „ *oxalate of lead* are equal to 2.43 grs. abt. $2\frac{1}{2}$ grs. *oxalic acid*.

POWDERED SUBSTANCES IN THE STOMACH.

Dilute the remaining portion of the contents C with water and project into a tall vessel, and observe if any white particles precipitate, if so, search for undissolved compounds of *arsenic*, *antimony*, *lead*, or *mercury*. It is not uncommon to find *arsenious acid* adhering strongly to the coats of the stomach.

Having *picked* out as much as possible of these white particles, dry them, and examine by sublimation tests, Reinsch's test, &c., or observe if any *yellow precipitate of lead* or *arsenic*, or any *red precipitate of antimony, lead, or mercury*, or any *green precipitate of a copper compound*, or if any pieces of *phosphorus*, exist (for de-

tecting *phosphorus* see that article, post). If none of these are visible then proceed to search for

VEGETABLE ALKALOIDAL POISONS.

Add to portion C some pure *cold hydrochloric acid*, and digest for several hours in a clean white ware basin, strain through cloth, and divide into three parts D, E, F. Evaporate portion D to an extract by a water-bath, treat the residue with absolute *alcohol* acidified with a few drops of *acetic acid* or *hydrochloric acid*, heat a little, filter through paper, and evaporate again to dryness, as often as necessary, so as to free it from all adhering animal matter; a good portion of which, where it is admissible, may be destroyed or carbonised by the joint action of *sulphuric acid* and the heat of a water bath. Finally dissolve the extract in a little water, transfer it to a sufficiently capacious phial, neutralise the acid liquor with a *slight excess of ammonia* or *caustic potash*, and then agitate it with three or four times its bulk of *ether*; after a while decant or draw off the supernatant liquor by means of a glass syringe or pipette, and evaporate spontaneously in a glass dish (or *chloroform*, which is a much *better solvent*, may be used, but as this by reason of its density falls to the bottom, the water becoming the supernatant liquor must be drawn off as before, and the *chloroformic solution* evaporated to dryness. (See article *Nux Vomica*, post.)

Note the character of the dry residue. If *bitter* to the taste, and not due to *bile*, probably *strychnia*, *brucia*, or *picrotoxia* may be present. If no crystals, but an oily residue be obtained, *fatty matter* may possibly be present and become solid on evaporation (*conia* and *nicotine*,

though oily substances, can hardly be expected to be found, owing to the heat used having dissipated them); wash the fatty matter with a little water and *acetic acid*, and evaporate to dryness to separate any pure *alkaloid* that may be mixed up with it.

Morphia is *not soluble* in *ether* or *chloroform*, so that the neutralised residue D must be evaporated to dryness, treated with hot *alcohol*, filtered, and again evaporated to dryness, which will probably afford the *morpbia* in crystals. (See article *Opium*, post.)

STRYCHNIA.

This poison is obtained from *Nux vomica*. The fatal dose is variable. An adult may be killed by from $\frac{1}{2}$ to 2 grains, in some cases even less than that has been fatal; $\frac{1}{16}$ killed a child in four hours. Half a grain is about the smallest dose known to have killed an adult (a woman). Larger doses have been taken without proving fatal, but seldom without the usual tetanic symptoms being observed. (See *Nux Vomica*, post.) To prove the *poisonous effect*, experiments should be made on some *small animal* with a portion of the solid poison obtained, also with the administration of some of the contents of the stomach, &c. to dogs or cats. Dr. Marshall Hall in his experiments on frogs, noted the effect of $\frac{1}{5000}$ part of a grain diffused through the water in which they were placed. In some instances the poison is placed *under the skin* of the chest or abdomen.

Tests.—1. A portion of the solid residue on being drenched with strong *sulphuric acid* in a white ware dish or plate, and then touched with a crystal of *bichromate of potash*, a deep purple or violet colour (No. 6,

coloured plate) is produced, changing to red.—2. *Precisely the same reaction* takes place when a little *peroxide of manganese* or *red prussiate of potash* is added to the acid solution. By these it is distinguished from every other vegetable poison. (See *Aniline*, post.)

$\frac{1}{5000}$ of a grain is clearly detectable, and by very careful manipulation even so small a quantity as $\frac{1}{100000}$ may be identified (for process, see article *Traces*, post).

BRUCIA.

This poison, like *strychnia*, is also obtained from *Nux Vomica*, and is often associated with commercial *strychnia* to such an extent, as to impart a *colour* to it when touched by *sulphuric acid*; but *pure strychnia* forms with *sulphuric acid* a *colourless* solution. When therefore *strychnia* is discoloured it is due to its contamination with *brucia*. From its being only met with in the laboratory, as a chemical, poisoning cases with this substance are not likely to occur; its effects on the system are *not quite so powerful* as *strychnia*.

Tests.—1. The reagents for *strychnia* will not apply to this *alkaloid*, which is turned reddish yellow (No. 7, coloured plate) when touched with strong *nitric acid*; and on being warmed and *chloride of tin* added, a bluish or light violet colour (No. 10, plate), is formed altogether distinct from that produced by *strychnia*.

2. *Sulphuric acid* produces a rose colour (No. 16), which soon disappears.

VERATRIA.

This poison is obtained from *white hellebore*, and is remarkable for producing *violent sneezing* which lasts for some time. It is in the form of a pale brown coloured *uncrystalline powder*, which is *very acrid* to the taste.

Tests.—The *merest trace* heated or boiled in a test tube with *hydrochloric acid*, strikes a deep carmine colour (No. 9, coloured plate), as does *hot sulphuric acid*, but the latter in its *cold* state produces a yellow or orange colour (No. 8, in coloured plate). Acid solutions of *veratria*, unlike those of *strychnia* and *brucia*, are *not precipitable* by *alkalis*, hence to extract it from aqueous solutions by *ether* or *chloroform*, the same rule applies as to *atropia* (which see).

MORPHIA.

This poison is obtained from *opium*. 10 grains of the crude drug are said to be equal to 1 grain of *morphia*, which, when once separated in a *solid* state can be easily recognised, but it is not often so obtained from the stomach or other organs, owing to the rapidity with which it is absorbed, and thus becomes *altered or removed* from the system. There does not seem any case on record where the *absorbed poison* has been chemically recovered. Dr. Christison could not detect a particle of *morphia* in a case where so large a quantity as two ounces of *laudanum*, or the *tincture of opium*, had been taken and proved fatal. Drs. Pereira, Taylor, and others, state the same; and that it is doubtful if it can be detected or obtained as a *corpus delicti*, if not from the stomach. A remnant of the contents of a bottle, or cup which contained the poison, may possibly yield traces of *morphia*, or its acid associate '*meconic acid*'.

It is difficult to assign what may be termed a *fatal dose*, as many persons have been known to take *with impunity* large doses of *opium* or *laudanum*. On the other hand a grain, or even less, has proved fatal to children.

Persons habituated to *opium* can always take more than others.

Tests.—1. *Nitric acid* applied to a little of the solid *morphia*, on a white plate, imparts an intense orange red (No. 4, coloured plate), which gradually changes to yellow. Its solutions are also changed red by this acid.

2. A solution of *morphia* turns a solution of *iodic acid* brown with the liberation of free *iodine* which discolours starch paper blue (No. 3 in plate).

3. *Perchloride of iron* produces an indigo or slaty blue colour (No. 2, coloured plate), becoming *green* by diffusion.

4. Mixed with a solution of *ferridcyanide of potassium* the liquid after a few hours becomes a cherry-red (No. 15, plate). (Horsley.)

5. A hot acetic solution of *morphia* mixed with a few drops of *nitrate of silver*, reduces it to a metallic state, and on filtering the liquor the *blood red* of *morphia* (No. 4) is developed on the addition of *nitric acid*. By this it is distinguished from every other alkaloid. (Horsley.)

This test will detect $\frac{1}{200}$ of a grain of *morphia*.

There is one principle with which *morphia* is always associated in the crude drug, so that its presence is to be inferred although we may not be able to extract the *morphia* from the contents of the stomach, viz.: *meconic acid*, which should likewise be sought for. It is identified by the peculiar blood-red colour which it produces with a *persalt of iron* (No. 4, plate). In a subsequent paragraph I will give the precise mode of extracting it from *opium* (see that article, post).

ACONITINA.

This poison is obtained from the root of the plant called *Aconitum Napellus*, or *monkshood*—sometimes called *wolfsbane*. It is very powerful in its pure state, $\frac{1}{100}$ of a grain poisoned a mouse, $\frac{1}{300}$ a small bird; even $\frac{1}{1000}$ causes a tingling sensation on the tongue, and a hot acrid sensation in the throat.

Poisoning by *aconite root* sometimes occurs from mistaking it for *horseradish*, but there are *striking differences*: horseradish root being of a *long, cylindrical shape*, of the same size and thickness for *many inches*, and whitish yellow outside, having a powerful pungent odour when scraped, whilst *aconite root* is *short and conical*, tapering *rapidly to a point*. Externally its colour is of an *earthy brown*, but white inside, having a strong earthy odour. Numerous cases of poisoning by means of its alcoholic extract or tincture have occurred.

The separation of this poison in a post-mortem analysis seems at present almost an impossibility, owing to the change which has taken place in the *organism*, as well as by the decomposition it undergoes during the process of evaporation and exposure to the air, by which it becomes converted into *ammonia*; nor are there any peculiar chemical reactions by which it can be readily identified. Its physiological, that is, its *benumbing and paralysing*, effects are the only prominent ones.

Tests.—1. The *solid* poison assumes, when drenched with *nitric or sulphuric acid*, particularly the latter, a deep sepia brown colour, on being heated (No. 11, plate).

2. A solution of the *pure alkaloid* is precipitated

white by all the *alkalis*, but is *redissolved* on the addition of more water, by which it is distinguished from *atropia*.

3. *Chloride of gold* produces an abundant *curdy* whitish yellow precipitate with this *alkaloid*, becoming dissolved on standing, but no precipitate is produced by *chloride of platinum*, which is characteristic of *aconitine*.

ATROPIA.

This poison is obtained from *belladonna*, or *deadly nightshade*, and, like *aconitina*, is with difficulty, if ever, obtained in a post-mortem analysis, and must also be judged of by its physiological action. Its effect on the PUPIL OF THE EYE is very characteristic, even one or two drops of a solution of *sulphate of atropia* mixed with 9,500 parts of water, cause a considerable dilatation, which lasts from thirty to sixty minutes.

Tests.—Notwithstanding the difficulties attending its extraction from the dead body, still if once obtained in a solid state from the remains of a bottle, or otherwise, there are certain peculiarities by which it can be distinguished from *aconitina*. 1. A small portion drenched on a white plate, or porcelain dish with *sulphuric acid*, and warmed, gives a rose colour (No. 16, plate).

2. *Chloride of gold* produces with its solution a smooth yellow precipitate, which is at first amorphous, but in about half an hour or so, beautiful yellow crystals form, of a *rhomboidal plate-like* shape, not unlike crystals of *nitrate of urea*, which are readily distinguished by the microscope. (Horsley.)

3. *Chloride of platinum* forms with it a yellow *curdy* precipitate. A solution of *atropia* is not, like *aconitina*, precipitated by caustic *alkalis*.

As *atropia* is freely soluble in acids and alkalis it is obvious that in order to extract it by agitation with *ether* or *chloroform* the solution should be rendered as NEUTRAL as possible.

According to Planta, and Dumas, '*daturia*', the active principle of the seeds of *Datura stramonium*, or *thorn-apple*, is analogous to *atropia* in its effects on the system, but, chemically speaking, it differs from *atropia*, in being precipitated by the alkalis.

NICOTINA.

This alkaloid is obtained from *tobacco*. It is of an oily character, and of a most deadly nature, acting on the system like *prussic acid*, and like it contains no oxygen, being composed of *nitrogen*, *carbon*, and *hydrogen* only. Being rarely met with, it is not often had recourse to for poisoning purposes. It was specially prepared for and used in a celebrated case by Count Bocarmé of Belgium, for poisoning his wife's brother. It was also used for a suicidal purpose by an English chemist, named Witt, and proved fatal in less than five minutes. A single drop will kill a large sized dog. It may be extracted in the cold way by digestion of the contents of the stomach, &c., in dilute *hydrochloric acid*, and after filtration supersaturating the liquid with *potash* or *soda*, and agitating the liquor with *ether*. On allowing a few drops of the ethereal solution to evaporate spontaneously in a glass dish, the impure *nicotina* is obtained as an oily product, recognisable on being heated, by the peculiar odour of *tobacco* evolved. It is soluble in water, and separated from it by *potash* in oily globules. In order to obtain it pure the ethereal solution should be first shaken up with water containing $\frac{1}{5}$ of *sulphuric acid*, which

dissolves the *nicotina*, forming a *sulphate*; the *ether* is then poured off and the aqueous solution again neutralised with *potash*, and agitated with fresh *ether*: the supernatant liquors, on spontaneous evaporation, leave the *nicotina* in the form of an *oil*, which, on being warmed, can be recognised by the odour of *tobacco*.

Tests.—1. A solution of *nicotine* in *hydrochloric acid*, affords with *chloride of gold* a reddish yellow, curdy precipitate (No. 8 plate).

2. Also, with *chloride of platinum* a crystalline, yellow precipitate (No. 13).

3. Heated with *hydrochloric acid* a *violet* colour is produced.

CONIA.

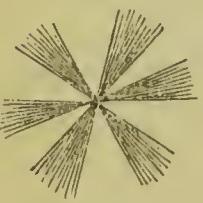
This poison is obtained from *hemlock*, or as Shakespeare has it ‘the cursed juice of *hemlock*.’ It is not crystallisable but of an oily nature, like *nicotina*. It can hardly be expected to be obtained from a dead body, and is incapable of recognition by chemical tests. It differs from *nicotine* in not being soluble in water. It has a peculiar odour, resembling that of dead mice, and is very benumbing in its effects—little else is known of it.

PICROTOXIA.

This is the active principle of *Cocculus indicus*, popularly known as Fishberries, from their being used to intoxicate fish by throwing the bruised berries into streams, and on rising to the surface to partake of it, the fish becoming soon intoxicated, are easily caught by those who understand its effects. The berries are some-

times used by fraudulent brewers for the purpose of falsifying the strength of beer, and thus save the use of so much malt; but the practice is prohibited by law. The pure crystals of the berries (for it is not considered an alkaloid in the true sense of the word, as it is destitute of *nitrogen*, and not capable of precipitation by alkalis), are obtained by digestion of the aqueous extract in water acidified by *hydrochloric acid*, and agitating the acid fluid with *ether*, when the ethereal

Fig. 4. solution yields the poison by spontaneous evaporation in fine feathery-form white crystals. If these, freed from all colouring matter, are dissolved in a small portion of boiling water, as the liquor cools long branchiform spiculæ slowly form.



To extract it from beer and other highly coloured liquids we proceed as follows: *acetate of lead* is first used to precipitate all the colouring matter; the excess of lead in solution is then thrown down by the careful addition of q. s. of a solution of *oxalic acid*; the liquid filtered and evaporated to a small bulk, and when cold agitated with *ether* as before, by which the *picrotoxia* is obtained pure.

Test.—In addition to the microscopic test, there is only one chemical one of a striking character, viz. the use of *sulphuric acid*. A small portion of the solid *picrotoxia* placed on a white plate and touched with a drop or so of the acid produces a yellowish-brown colour, and if the smallest portion be put into a test tube containing *sulphuric acid*, and heat applied, a dark-brown colour results (No. 11 plate).

For further particulars (microscopic and chemical) on the vegetable poisons, see article *Physical Characters of Alkaloids*, post.

If no vegetable poisons are present in any of the contents of the stomach, we proceed for

METALLIC POISON

by first boiling portion E of the acidulated contents of the stomach, and then inserting some *bright* copper foil, gauze, or wire, when, on continuing the ebullition, say for ten minutes or so, possibly *arsenic*, *antimony*, or *mercury* may be deposited thereon in a *metallic form*, which is considerably heightened by rubbing, after withdrawal from the liquid.

Arsenic and *mercury* are easily distinguished by the application of the heat of a spirit lamp to the bottom of a test tube containing the pieces of coated copper,— the *arsenic* assuming a white brilliant, crystalline appearance, like *little diamonds*, (*arsenious acid*, or *teroxide of arsenic*) at the colder end of the tube; whilst *mercury* is sublimed into *silvery globules*, which, when touched with any pointed instrument, run into one large globule, and stains gold, copper, or brass silvery white when rubbed upon them, and is entirely dissipated by heat.

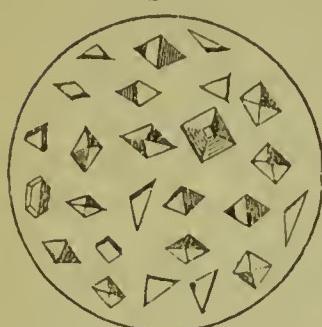
Antimony, if present, is dissipated by a stronger heat

Fig. 5.



as a white uncrySTALLine powder only (*antimonious acid* or *teroxide of antimony*), which is perfectly insoluble in

Fig. 6.



Crystals of arsenious acid under microscope.

water, and is therefore easily discriminated from the 'diamond-like crystals of arsenic,' which readily form a clear solution in boiling distilled water, and is fit for testing in various ways, as follow.

Tests for arsenic. 1.—A few drops of a neutral solution of *ammonio-nitrate of silver** added to a solution of the *arsenical sublimate* above mentioned, produce a lemon-yellow precipitate (No. 17 plate) of *arsenite of silver* which is soluble in *aq. ammoniæ*.

2. *Ammonio-sulphate of copper*† produces an apple-green precipitate (No. 1 plate) of *arsenite of copper*, known as *Scheele's green*, so extensively used for making green coloured paper, sugar ornaments, &c.

To test the presence of *arsenic* in *green wall papers* immerse a piece in a dish containing a little *ammonia water*; after standing some few minutes pour off the blue liquid into a test glass, and throw in a crystal of *nitrate of silver*, when a *yellow* precipitate of '*arsenite of silver*' forms at the bottom. The quantity of *arsenite of copper* contained in a *given size of the paper* may

* *Ammonio-Nitrate of Silver*.—Make a solution of the *nitrate* adding *gradatim liquor ammoniæ*, observing the same precaution as in making *ammonio-sulphate of copper*.

† *Ammonio-Sulphate of Copper*.—This test is best prepared as follows:—Make a solution of the *sulphate* (not too strong), then add *gradatim liquor ammoniæ* until the *oxide*, which is at first precipitated, is nearly but *not entirely* re-dissolved, for if it contain *ammonia* in *excess*, the *arsenite of copper* will *not be thrown down* in cases where the contained *arsenic* is very small.

easily be ascertained by digestion in weak *ammonia water* and evaporation to *dryness* over a water bath, the resulting green powder being equal to 50 per cent. of *arsenic*.

3. *Sulphuretted hydrogen*, as well as *yellow sulphide of ammonium*, produce in *ACID* aqueous solutions of the *arsenical sublimate* a golden yellow precipitate (No. 13 plate), which is increased on boiling. This yellow precipitate is readily soluble in *ammonia*, but quite insoluble in *hydrochloric acid*. On the other hand, a *sulphuret of antimony*, which is of an orange colour (No. 7 plate), when similarly treated is insoluble in *ammonia*, but readily dissolved by hot *hydrochloric acid*, the solution becoming *milky* and *precipitable* on the addition of water, which characters are just the inverse of *arsenic*.

4. If another portion of the solution of the *arsenical sublimate* be acidified with *nitric acid* and evaporated to *dryness*, it will have become changed from *arsenious* into *arsenic acid*, and its solution in distilled water on being treated with *ammonio-nitrate of silver* will then give a brick-red precipitate (No. 14 plate) of *arseniate of silver*, instead of the *yellow arsenite* already mentioned, neither of which coloured precipitates are produced from *antimony*, so that the identification of *arsenic* or both is remarkably easy and conclusive. Any *antimonial* deposit on copper obtained by Reinsch's process is easily dissolved off by boiling in *liq. potassæ*, occasionally exposing the copper to the action of the air to become oxidised, and returning it again to the hot alkaline liquor, which, on filtration and the addition of *hydrochloric acid* in slight excess, yields an orange red sulphide by subsequent treatment with *sulphuretted hydrogen*.

If any *white powder* be produced on sublimation which is *insoluble* in water, but readily so in a solution of *tartaric acid*, and a stream of *sulphuretted hydrogen* passed through it should form an orange-red precipitate, it is a *sulphide of antimony*, which, though readily soluble in *sulphide of ammonium* or *hydrochloric acid*, is quite *insoluble in aq. ammoniae*, which is confirmatory of the characters of *antimony* previously stated.

From what has been said before respecting the *insolubility* of *sulphide of arsenicum* in *hydrochloric acid*, it is obvious that, in cases where it exists in the stomach *as such*, Reinsch's test (viz. that of boiling the copper foil or wire in the acid liquid) would *fail to detect* the insoluble portion. *White arsenic* is more commonly the poison used, but there have been cases known in which the *sulphurets of arsenic* (such as the yellow or *orpiment*, and the red or *realgar*) have been taken, and are extensively used in some workshops for fireworks. Then again where a corpse has been long buried and is disinterred for examination, the *white arsenic* taken by the deceased has become, by the putrefaction of the body, changed into the *yellow sulphuret*:—in all these cases the use of *hydrochloric acid* as the solvent, and Reinsch's process as the precipitant, cannot apply, as the *arsenic* is liable to be overlooked.

Therefore, supposing the *arsenic* to exist in the stomach in the state of *sulphuret*, in order to extract it we must digest the contents of the stomach in *nitric acid*, and the mass be afterwards diluted with water, and the filtered solution evaporated to *dryness*, when it is obtained in the form of *arsenic acid*; this is now dissolved in distilled water and treated with *ammonio-nitrate of*

silver, to produce the characteristic red precipitate of *arseniate of silver* (No. 14 plate), from which, by sublimation, crystals of *arsenious acid* may be obtained, and tested as before stated.

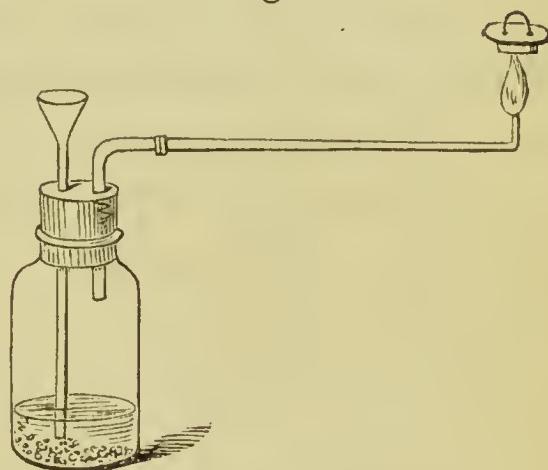
Or the solution may be put into a *Marsh's test apparatus*, and evolved as *arseniated or antimoniated hydrogen*, and burnt—a porcelain plate being applied to the flame, so as to obtain the *metallic spots*.

In order to obtain the metallic spots of arsenic or antimony by *Marsh's apparatus*, proceed as follows:—Place in the gas bottle a few pieces of *distilled zinc*, and pour over it some diluted sulphuric acid with the *solution* to be *tested*; the hydrogen as it is evolved carries with it any arsenic or antimony present, and on being burnt, leaves the metallic spots, but if the same are produced with zinc and acid only, the materials are impure. Care is required to avoid an explosion with the confined air, which must first be allowed to escape.

Arsenic spots are of a *nutty brown colour*, whilst those of *antimony* are of a *smoky black*. These spots are easily distinguished by the application of a drop or so of a solution of *hypochloride of soda*, which readily dissolves arsenic but not antimony spots. *Tartaric acid* also dissolves antimony, but not arsenic spots.

Either of the foregoing precipitates of arsenic may be tested by the following processes of reduction, thus:—

Fig. 7.



The yellow *sulphide* (previously dried by the heat of a water-bath, so as to expel all moisture) may be reduced by mixing 1 part with 2 parts of finely reduced, pure *silver*, putting the mixture into a glass tube, and on applying a gentle heat the *silver abstracts the sulphur*, whilst the *arsenic* is volatilized and combining with the *oxygen* of the air forms crystals of white *arsenic* which collect in the *upper part* of the tube, and after being chased backwards and forwards they are fit for solution in hot distilled water, and can be tested accordingly (Horsley), or, instead of *silver* 3 parts of black *oxide of copper* may be mixed with 1 of the *sulphide*, and heated in the same way with a similar result. (Horsley.)

Or 2 parts of *oxide of tin* (putty powder) may be used with 1 of the *sulphide*. In this case the sublimed crystals are of great size and brilliancy. (Horsley.)

What is called the 'arsenical mirror' may be obtained, say from the green *arsenite of copper*, by mixing some dried *carbonate of soda* and *charcoal* with it, or some *carbonate of soda* and powdered *cyanide of potassium* or even with the *sulphide of arsenic*, and fluxing them in a test-tube, when a beautiful *resplendent mirror* forms in the upper end, which by reheating backwards and forwards, is converted into crystals of *arsenious acid*.

But it should be stated that the *best* reducing agent of the *sulphide of arsenic*, or *arsenite of copper*, is the mixture of *cyanide of potassium* with either *carbonate of soda* or *potash*, as this gives off *all* the *arsenic*; whereas, with *black flux* (that is, *charcoal* and *soda*) only *half* is evolved. My friend Dr. Davy, of Dublin, has suggested the use of powdered yellow *prussiate of*

potash as answering every purpose, which I can, bear testimony to.

Failing the finding of *arsenic* by ordinary means, recourse is sometimes had to the French process of carbonisation. A portion of the liver or other organ being first drenched with *sulphuric acid* and desiccated by the heat of a sand-bath, the charred mass is next moistened with *nitro-muriatic acid*, and evaporated again to dryness, then boiled with distilled water and filtered, the filtrate containing the *arsenic acid* being afterwards used in a Marsh's test apparatus, for the purpose of obtaining the metallic spots, or to be converted into a sulphide, &c.

Having thus clearly described the methods of manipulation and testing by which *arsenic*, *antimony*, and *mercury* are to be recognised, it is worthy of observation that these poisons are not always to be detected, although known to have been taken. A girl, for instance, according to Dr. Taylor, took an ounce of *arsenic* and died in seventeen hours, while another took two ounces, and died in eight hours, but no *arsenic* was found in either case!

In the case of *absorbed arsenic*, if a person survive fifteen or sixteen days it is not unusual to find no trace of it after death. Dr. Geoghegan of Dublin had a case where a gentleman ate some arrow-root containing *arsenic*, and died from its effects in sixteen days, without a particle being found in the body, it having been all eliminated during life.

As to the time a dose of *arsenic* may prove fatal, even that is difficult to define, as there appears to be no uniformity of its action on different systems. Death

has occurred within two or three hours of taking the poison.

The *probable* fatal dose under favourable circumstances is about two or three grains, but much larger quantities have been taken without death ensuing.

PHYSICAL CHARACTERS OF THE DEPOSITS ON COPPER BY REINSCH'S TEST.

Mercury of a white silvery colour, and sublimes into *metallic globules*, which adhere on touching.

Arsenic of a steel grey, and sublimes into 'white crystals' soluble in hot water.

Antimony of a *violet* in small quantities, but *white* in larger, and yields a white powder *not soluble* in water.

SENSIBILITY OF REINSCH'S TEST.

Antimony shows clearly at $\frac{1}{75000}$ of a grain. (Horsley.)

Arsenic „ „ $\frac{1}{500000}$ „ (Horsley.)

The yield of *sublimate* however may *not be sufficient* for chemical tests. The sensibility of Marsh's test is said to be from $\frac{1}{500000}$ to $\frac{1}{1000000}$.

SENSIBILITY OF THE CHEMICAL TESTS.

Sulphide of hydrogen will detect $\frac{1}{1000000}$ of a grain of *arsenic* (the extreme).

Sulphide of hydrogen will detect $\frac{1}{500000}$ of a grain of *arsenic* (clearly).

Sulphide of hydrogen will detect $\frac{1}{100000}$ of a grain of *antimony*.

Sulphide of hydrogen will detect $\frac{1}{80000}$ of a grain of *mercury*.

Am. nitrate of silver shows $\frac{1}{150000}$ of a grain of *arsenious acid*. (Horsley.)

Am. nitrate of silver shows $\frac{1}{12000}$ of a grain of *arsenic acid*. (Horsley.)

Amm. sulp. of copper shows $\frac{1}{50000}$ of a grain of *arsenious acid*. (Horsley.)

EQUIVALENT PROPORTIONS OF THE RESPECTIVE
PRECIPITATES.

These have been drawn out at tenths, so that by putting a figure to the right, or left, according to weight, the quantities are readily ascertained : thus —

10 grs. sulphide of arsenic equal to 6·98 grains *arsenicum* or 7·57 oxide of arsenic (white arsenic).

10 grs. sulphide of antimony equal to 7·28 grains *antimony* or 27·30 of *tartar emetic*.

10 grs. sulphide of mercury equal to 9·26 *mercury*.

10 grs. arsenite of copper equal to 5·26 or better than 50 per cent. *arsenious acid*.

10 grs. arsenite of silver equal to 2·99 or 3 grains *arsenious acid*.

10 grs. arseniate of silver equal to 3·30 *arsenic acid*.

FURTHER RESEARCHES FOR METALLIC POISONS.

If neither arsenic, antimony, nor mercury exist in the contents of the stomach, then proceed to search portion F for other metals as *lead*, *copper*, *zinc*, &c., by passing a stream of *sulphuretted hydrogen* through the liquid, and examining the precipitate obtained for the respective metals, although it can hardly be supposed that more than one is present.

Nitric acid added will on evaporation to dryness convert them into *nitrates* and *sulphates* sufficiently available (save the *sulphate of lead*) for identification ; which latter, from its well known *insolubility*, must be treated in a different manner.

COPPER.

Test 1.—A portion of the solution of the residue left by the action of *nitric acid* after being slightly acidulated may be tested with a clean piece of iron, as a polished

steel needle or the blade of a knife, when, after a short immersion, copper, if present, will be deposited thereon as a thin film, easily recognised by its colour ; or it may be deposited on platina by inserting a piece of zinc and platina foil in the acid fluid containing copper in solution.

2. Another portion may be treated with *ammonia*, which should produce the characteristic blue colour (No. 3 coloured plate).

3. Another portion may be treated with a solution of *yellow prussiate of potash*, which should give a reddish or chocolate-coloured precipitate (No. 14 coloured plate).

The *prussiate of potash* test will show $\frac{1}{60000}$ of a grain of *copper*. (Horsley.)

10 grs. *sulphide of copper* are equal to 6.66 or more than $6\frac{1}{2}$ grains *copper*, or 26 grains *sulphate of copper*.

Sulphate of copper, or *blue vitriol*, is sometimes used as a poison, but not often, poisoning by copper being more frequently the result of accident, possibly due to the verdigris, or *oxide of copper*, derived from the use of uncleaned vessels in which the food has been cooked.

The *fatal dose* is variable. As much as 5 drachms of the *sulphate* have been taken without proving fatal. Smaller doses are said to be more fatal or injurious than larger ones, owing to the emetic action induced by the latter, which expels the poison.

ZINC.

Test 1.—Another portion of the solution of the residue left by the action of *nitric acid* should now be treated with a current of *sulphide of hydrogen*, when if a *white* precipitate forms, it must be zinc, as no other metal comports itself thus.

2. Another portion of the solution treated with *car-*

bonate of soda will produce a white precipitate, which should be collected on a filter, well washed, and dried. To test it still further, place a portion of this dried precipitate of *carbonate of zinc* in the hollow of a piece of charcoal, and having moistened it with a drop or so of a solution of *nitrate of cobalt*, on applying the heat of a blowpipe flame to it, and heating it strongly, it should turn green (No. 1 coloured plate). This reaction always indicates zinc.

Sulphate of zinc is often used as an emetic ; but numerous instances have been known where *chloride of zinc*, in the form of Burnett's disinfectant fluid, has proved fatal.

LEAD.

The insoluble *sulphate of lead* left after the action of *nitric acid* on the sulphide may be decomposed by boiling it with a solution of *bicarbonate of soda* or *ammonia*, to convert it into a *carbonate*. Allow the mixture to stand a while for the precipitate to subside; drain off the superfluous water, wash a little more, and again drain off the liquor ; the precipitate is now in a fit state to form a clear solution on being digested in dilute *nitric acid*.

Tests.—1. A drop or so of a solution of *chromate of potash*, added to a portion of the liquid, produces a yellow precipitate (No. 13 coloured plate) of *chromate of lead*, known by its insolubility in *acetic acid*, but is soluble in *hydrochloric acid*, and can be thus easily separated from all other chromates of metals.

10 grs. *chromate of lead* are equal to 6.83 grs. *ox. of lead*.

This test will detect $\frac{1}{100000}$ part of a grain of lead.
(Horsley.)

2. A drop or so of a solution of *iodide of potassium* also produces a yellow precipitate of *iodide of lead* (No. 13 coloured plate), which is soluble in *boiling water*, and on cooling it is again deposited in very brilliant scales.

This test will show $\frac{1}{10000}$ of a grain. (Horsley.)

10 grs. *iodide of lead* are equal to 4·52 or $4\frac{1}{2}$ grs. of *lead*.

3. A deposit of metallic lead may be obtained by placing a little of the solid nitrate, or carbonate, on a sovereign, drenching it with *hydrochloric acid*, and then touching it with a piece of zinc. *Lead* may be frequently extracted thus from the evaporated residues of water, without the use of *sulphide of hydrogen*.

4. *Sulphuric acid*, or either of the *alkaline sulphates*, when added to another portion of the solution produces a dense white precipitate (No. 5 coloured plate) of *sulphate of lead*, insoluble in water, and turns black or brownish-black, according to the quantity (No. 12 coloured plate), with a weak solution of *sulphide of ammonium*, by which it is distinguished from the corresponding white precipitates of *sulphate of baryta* and *strontia*.

10 grs. *sulphide of lead* are equal to 8·637 grs. *lead*, equal to about 16 grs. of *acetate of lead*.

The form in which lead is taken for criminal purposes is that of *acetate of lead* or sugar of lead, or as *Goullard's Extract*, which is a solution of lead in vinegar. Wine has been known to have proved poisonous, probably from the practice of cleaning bottles with leaden shot. Water also is liable to become contaminated with lead by being kept in leaden pipes and cisterns, particularly if it contains much *alkaline nitrates* or *chlorides*.

This completes the examination of the contents of the stomach for every supposed poison, and if any be found it is evidently the portion which had remained over and above that which has been absorbed into the system and produced death.

EXAMINATION OF THE BLOOD, URINE, CONTENTS OF INTESTINES, THE STOMACH, LIVER, AND OTHER ORGANS, FOR

ABSORBED POISON.

This, as might be supposed, is always attended with more or less difficulty, from the poison being contaminated with so much *animal matter* as to require numerous processes to be gone through before it can be obtained in a *sufficiently pure* state for chemical testing.

As regards the ‘vegetable poisons,’ it is *very questionable* whether, having been absorbed and passed through the circulation, they can be found at all; and in many instances even the *more stable poisons*, as the mineral or metallic, although known to have been taken in some form in pretty large doses, *could not be found*, owing possibly to their expulsion from the stomach by *vomiting*, or their elimination from the system by *purgating*, as well as by the urinary organs.

On the other hand, one or other of the organs may contain *some traces*, whilst others none at all. In general the largest portion of any absorbed poison is found in the liver or spleen, as also in the contents of the bladder. The urine, being one of the principal outlets, should always be examined for poison, although it is unfortunately too often *overlooked*. The stomach is in general the organ most frequently sent to the chemist for examination, but that is a mistake; for if the poison has

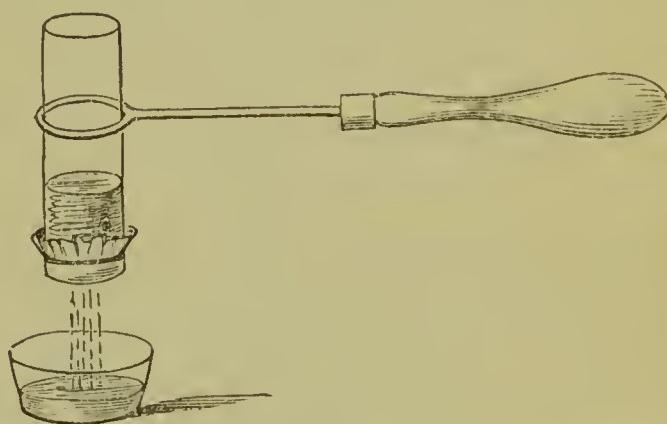
passed the stomach, the various other organs require to be operated on before any *satisfactory inference* can be drawn as to the cause of death.

As it is desirable to know from which *organ or part* any poison has been extracted, it is necessary to operate on a given portion of *each separately*, well slicing or mincing it on a board with a clean sharp knife, before commencing a digestion in any acid fluid, taking especial care that the chemicals to be used are *perfectly pure*.

Having taken the intestines, slit them open, and wash them out with a small quantity of pure water in a basin, and notice the character of the contents; also observe if there be any signs of inflammation or ulceration, making a note of the inflamed parts.

The organ being well sliced, minced or pulped, digest it for several hours in a vessel of cold dilute hydrochloric acid. After filtration, take $\frac{1}{3}$ of the liquor and search for *arsenic, &c.*, by Reinsch's process, page 19, and

Fig. 8.



Small filtering apparatus for collecting precipitates.

through the remainder pass a good stream of *sulphuretted hydrogen gas*. On boiling the liquor to expel all free *sulphuretted hydrogen*, allow it to cool and the precipitate to collect at the bottom of a conical glass vessel,

when by careful decantation of the supernatant liquor, and *tilting* the vessel from time to time, the whole of the residue may be collected on a small filter,—by *preference* a small test tube may be used, the round or *closed end* having been *filed or cut off*, and a tiny *double* paper filter *tied on to the rim* by cotton thread, and supported by means of a clip; this admits of *much less loss* or waste, when the quantity is small, than an ordinary filtering vessel, and the precipitate is more conveniently dried and weighed.

In like manner the *contents of the intestines*, the liver, spleen, and other organs, should be *individually* experimented on, also the urine; the latter may possibly yield evidence of vegetable as well as mineral poison. *Strychnia*, for instance, has been found in it when nowhere else, or at most in but small traces. In the case of Dr. Pritchard's victims antimony was detected *in abundance* in the urine by acidulating it with tartaric acid and passing a stream of sulphuretted hydrogen through the liquid; also by Reinsch's process.

Blood or urine may be searched for *strychnia* and other vegetable poisons by the addition, in the first place, of a few drops of *acetic* or *hydrochloric acid*, and then an equal volume or so of *alcohol*. The mixture, after warming a little, should be filtered, and then carefully evaporated to dryness over a water-bath, the residue again dissolved in a little water, and, if acid, neutralised with *ammonia* in slight excess, and agitated in a stoppered bottle with *ether* or *chloroform*, as stated under the head of Vegetable Poisons, page 9.

Should none be found, we may search the residue of the various extractive liquors, after having mixed them

and driven off any *ether* or *chloroform* present, for metallic poisons.

In order, however, to get rid, as much as possible, of any adhering animal matter, that the tests might not be obscured, the following method for its *destruction* is now generally adopted by analytical chemists.

To the acid liquid, whether clear or containing any portions of the organ, *powdered chlorate of potash* is added during the process of boiling, in about 15 or 20 grains at a time, every five minutes, till all the organic matter becomes disintegrated or *broken up*, and the liquid assumes a *pale yellow colour*. It will then filter easily through paper. After continuing the boiling to expel any free *chlorine*, it is allowed to cool. A good stream of *sulphurous acid gas* may now be passed through the liquid, or, what will do equally well, a few lumps of *sulphite of soda* may be thrown in and the liquor *well boiled*. When cold it is fit for passing *sulphide of hydrogen* through it to saturation. After the free *sulphide of hydrogen* has been expelled by re-boiling, the *sulphide*, if any metal be present, will be *precipitated*, and can be collected on a filter for examination; but even this will not be *absolutely free* from organic matter, which will have to be *further destroyed* by digestion with *nitric acid* and evaporation to dryness more than once, *aided* by *sulphuric acid* and the heat of a water-bath or low sand heat.

In order to prevent the possible escape during long boiling in an open vessel of any vapours of *chloride of arsenicum*, the operation may be conducted in a *closed* one, as a glass flask, matrass, or tubulated retort, to which a receiver containing acidulated water is attached, the condensed *chloride of arsenicum* being either estimated independently, or mixed with the acid liquid in

the retort previous to precipitation as a sulphide. *Antimony* under these circumstances is *not volatilised*. Some chemists prefer this method of *distilling chloride of arsenicum* from the dried contents of the stomach or any organ, the substance being put into the matrass or retort, drenched with *hydrochloric acid* and heated by a sand-bath.

In the case of *arsenic* or *antimony*, if previous tests have proved their existence, a *yellowish* or *reddish* precipitate* may be obtained by the treatment with '*sulphide of hydrogen*,' contaminated probably with more or less free *sulphur*, so that the moist precipitate should be digested for a short time in cold *nitric acid* to dissolve out the *arsenic* (the *antimony* being insoluble or nearly so), the residuary liquid diluted with distilled water and filtered, reserving the insoluble part for further treatment. Evaporate the filtered nitric acid solution to dryness, and if still yellow from containing *sulphur*, the solid residue *must be fused* carefully in a Berlin crucible, along with three or four times its bulk of *nitrate of soda* and *carbonate of soda*, till it becomes quite *white* on cooling. If *arsenic* be present, it will be obtained in the form of *arseniate of soda*, and is fit for sublimation or reduction, or as a precipitate of *red arseniate of silver*, or for obtaining the *arsenical spots* by Marsh's apparatus; or it may be converted at once into a pure *sulphide* by the action of a stream of *sulphuretted hydrogen* on a solution of the salt rendered freely acid by *hydrochloric acid*; but in the latter case the *arsenic acid* will require to be first converted into *arsenious acid* by *sulphite of soda* or *sulphurous*

* Tin may also be present as a *yellow* persulphide, the *protoxide* yielding a black or brown sulphide.

acid previous to the precipitation by *sulphuretted hydrogen*.

In order to insure the *entire absence* of *nitric acid* or *chlorine*, the fused mass mentioned must first be drenched with *sulphuric acid* and evaporated until *white fumes* of *sulphuric acid* evolve, when, on neutralisation with soda, the solution is fit for being converted into *arsenious acid* by saturation with *sulphurous acid*, and finally precipitated as a *sulphide*, *ut antea*.

In this manner the quantity of *arsenic* is estimated: thus, supposing 4 oz. of the liver, weighing say 5 lbs., yield $\frac{1}{10}$ of a grain of *yellow sulphide of arsenicum*, then $\frac{1}{10} \times 20$ would be equal to 2.00 (or 2 grains) for the *entire liver*, representing 1.219 grain of real metal, or 1.609 grain of *arsenical oxide* or *white arsenic*. This quantity, however, in any case can only be an *approximation* to the truth; and as there is always some unavoidable loss, it is usual to *double* the amount actually obtained, but it must be absolutely free from *sulphur* and organic matter.

Where the quantity of *sulphide of arsenic* or *antimony* is small, it may be best collected for weighing by *dissolving* it from off the filter by *sulphide of ammonium*, and evaporating the liquid to dryness in a *weighed* watch-glass or Berlin crucible over the heat of a water-bath.

If the precipitate obtained by *sulphide of hydrogen* consist of a mixture only of *arsenic* and *antimony*, a simple digestion in *hot hydrochloric acid* will separate the *antimony sulphide*, leaving the *arsenic sulphide*; or the *latter* may be washed out with *aqua ammoniae*, leaving the *sulphide of antimony* insoluble. The ammoniacal solution of the *arsenical sulphide*, on evaporation to dryness, will enable it to be weighed, and *vice versa* the *antimony* or both estimated.

FURTHER EXAMINATION OF THE YELLOW OR ORANGE
SULPHIDE OBTAINED FROM ANY ORGAN FOR ANTIMONY
OR TIN.

Arsenic either not being present, or separated from the yellowish or fawn-coloured precipitate, we have to ascertain if it contain *sulphide of antimony* or *tin*.

Treat the residue with *sulphide of ammonium*, filter the liquid, and evaporate to dryness, moisten it with *nitric acid*, and evaporate again to dryness; then fuse it in a Berlin crucible with some *nitrate* and *carbonate of soda*, when we may get either *antimoniate of soda* and *binoxide of tin*, or we may have a little *stannate of soda* mixed with *antimoniate*. If the fused mass dissolves entirely in water, *antimoniate of soda* cannot be present in the liquid, as the *antimoniate* is *insoluble*, but there may be *tin* in solution.

If the *undissolved* matter be *antimoniate of soda* with *oxide* or *binoxide of tin*, after being well washed and dried, the residue should be *again fused* with *cyanide of potassium*, by which either *tin* or *antimony* may be obtained in small *metallic globules*, which, after being well washed, should be collected on a filter and dried.

The metal is now gently heated with *hydrochloric acid*, which easily dissolves *the tin*. This may be tested as follows.

Tests for Tin.—1. A few drops of the tin liquor mixed with a dilute solution of *bichloride of mercury* produce a white (No. 5 coloured plate) precipitate, becoming grey on adding a little more of the tin liquor, and ultimately reduces *the mercury to globules*.

2. A few drops of the tin liquor produce with a solu-

tion of *perchloride of gold* a purple colour (No. 6 coloured plate), and a precipitate called '*purple of Cassius*'.

Tin is not often used for poisoning purposes, but instances have been known where dyer's liquor (a solution of tin in *muriatic acid*) has been taken.

If no tin be present, then some of the metallic globules obtained by fusion with *cyanide of potassium* must be treated with '*hydrochloric acid*' to which a few drops of *nitric acid* have been added, when *chloride of antimony* is formed.

Tests for Antimony.—1. Having heated the solution to expel all *nitric acid*, and mixed it with water, a *milkeness* is produced, showing the existence of *antimony*, and a dirty-white powder collects, called *algaroth powder* (No. 17 coloured plate), which is a *subchloride of antimony*.

2. On the addition of more *hydrochloric acid*, a *clear solution* will be obtained, particularly if slightly heated. If this be treated with a stream of *sulphuretted hydrogen*, the characteristic orange-red precipitate (No. 7 coloured plate) of *sulphide of antimony* is produced, the *equivalent proportion* of which to pure *antimony* and *tartar emetic* has been already given. See p. 27.

3. A little of the solution of *chloride of antimony* may be further tested for the *metallic spots* by Marsh's apparatus; but the above characters are quite conclusive.

Chloride of antimony (called *butter of antimony*) is sold to farriers and others, and is very corrosive. It is of a dark brown colour, growing *milky* on the addition of water.

EXAMINATION OF A BROWN OR BLACK SULPHIDE
OBTAINED FROM ANY ORGAN FOR MERCURY, COPPER,
BISMUTH, LEAD, ETC.

Should the precipitate obtained be of a *brown or black* colour, possibly some other metal, as *mercury*, *copper*, *lead*, or *bismuth*, may be present, and any *arsenic* or *antimony* which may be mixed with them is first extracted by *ammonia* and *hydrosulphide of ammonium*, which *dissolve the latter*, leaving the others insoluble.

Having well washed the residue with water and *ammonia*, evaporate the moisture from the residue over a water-bath, and digest it when dry in *nitric acid*; evaporate again to dryness, and redissolve in water for testing.

1. A portion may now be examined for *mercury* by *iodide of potassium*, which produces a scarlet-coloured precipitate (No. 9 coloured plate), becoming dissolved and *discharged* by an excess of the precipitating solution. $\frac{1}{5000}$ part can be thus detected.

2. Another portion of the mercurial solution applied to a piece of gold, a sovereign for instance, imparts a white stain if the spot be touched with a pointed piece of iron so as to form a galvanic circle. $\frac{1}{50000}$ can thus be detected.

3. A little of the solid mercurial salt placed on a bright plate of brass or copper, and drenched with a drop or so of a strong solution of *iodide of potassium*, will show a white silvery stain on the plate being wiped dry. $\frac{1}{500}$ of a grain may thus be easily detected.

4. Another portion of the mercurial solution may be precipitated by a solution of tin, as before stated, and

the dry residue sublimed in a small test tube to obtain the metallic globules of *mercury*. $\frac{1}{80000}$ part can be thus detected.

Evidence of the existence of *mercury* in *any kind of medicine*, as a powder, pill, or even ointment, may be proved by No. 3 Experiment. If no *mercury* is present in the solution of the *black sulphide* in *nitric acid* before mentioned, it may be tested for *copper* by *ammonia* to get the peculiar blue colour (No. 3), or the metallic copper may be deposited on a steel needle or a piece of platinum by the galvanic process. See page 28.

If no copper be present, *bismuth* may be searched for, a solution of which in free *nitric acid* deposits a characteristic white precipitate (No. 5 coloured plate) on the addition of water. This white precipitate obtained by the addition of water to *nitrate of bismuth* is BLACKENED by *hydrosulphide of ammonium*, whereas the precipitate obtained by the addition of water to *chloride of antimony* is readily soluble in *sulphide of ammonium*, and yields an orange colour (No. 8 plate) on evaporation to dryness, which cannot lead to a mistake between the two precipitates, although similarly produced by the mere addition of water to their solutions.

Bismuth being absent, then the solution may be tested for *lead* by the methods before given, page 30. This concludes the examination of the black or brown sulphide for all poisonous metals usually expected to be found in any of the organs in a *post-mortem* analysis.

ON POISONING BY OPIUM.

In a former part of this work I alluded to the difficulty of detecting opium preparations by its active

principle, '*morphia*,' after it has entered the system. We may, however, be able to trace the existence of *one* of its characteristic concomitants, '*meconic acid*,' either in the contents of the stomach, or in the remnants of the draught in a phial or cup on the premises.

The contents of the stomach or otherwise are to be first digested in water and *acetic acid*, boiled a little, and filtered. The clear liquor is now treated with crystals of *acetate of lead* so long as a precipitate forms, which precipitate consists of *meconate of lead*, and should be separated by filtration, reserving the filtered liquor and its washings for further proceeding.

The precipitate of *meconate of lead* is now suspended in a vessel of water, and *sulphuretted hydrogen* passed through to saturation ; on boiling and filtration the clear liquid should be *concentrated* a little by evaporation, when, if free from all smell of *sulphuretted hydrogen*, it is fit for testing for the presence of *meconic acid* by the application of a few drops of *perchloride of iron*, which should give a deep blood-red or claret colour to the liquid, not dischargeable by *bichloride of mercury*, which distinguishes it from the *sulphocyanogen* of the saliva, which also produces a somewhat similar colour with a *persalt of iron*.

Or, to shorten the process, and do away with the disagreeableness of using *sulphuretted hydrogen*, *sulphuric acid* may be substituted, and will answer quite as well. Scrape off the *meconate of lead* into an evaporating dish, mix it with water, and then add a few drops of diluted *sulphuric acid*, filter off the rose-coloured liquid, and test at once for *meconic acid* by the *perchloride of iron*.

The colour thus produced is sufficiently satisfactory,

even if *no morphia* be obtained, which, from what has been before stated, is doubtful, if it has once been absorbed, and even if it has not, it may be too small in quantity to be recognised. No other known substance but opium contains *meconic acid*, so that it is characteristic of opium. Several eminent chemists, however, as Christison, Taylor, and others, state instances where even this principle, as well as *morphia*, have not been found in cases where *opium had been taken*, from which it would appear to have been *decomposed* in the organism. On the other hand, Robiquet says that some samples of *opium* are naturally deficient, or do not contain *meconic acid*. I have never yet met with a sample which did not afford evidence of its presence.

To extract the *morphia*, the solution filtered from the *meconate of lead* in the first place, together with the washings, should be treated with a few drops of *sulphide of ammonium* to precipitate any *excess of lead*, boiled and filtered, and the liquor evaporated to an extract; redissolved in a little water, adding an *equal bulk* of *alcohol* with a few drops of *ammonia*; and boiled again briskly to half, or till nearly all the *alcohol* and *ammonia* have been expelled. Pour the liquor whilst *hot* into a glass vessel, and stir *briskly* with a glass rod until *cold*, when impure crystals of *morphia* and *narcotine* will be precipitated. When cold, filter and collect the crystals; wash with a little water to extract as much colouring matter as possible; then *dissolve them off* with a little solution of *oxalic acid*, boil the acid liquor with a few grains of animal charcoal to remove colour, filter and wash the residue, neutralise the liquor with a slight excess of either *carbonate of soda* or *potash*, and evapo-

rate to *dryness*, scrape out the residue, put it into a small phial and agitate with a little *ether* to extract the *narcotine*; having poured off the ethereal liquor into a glass dish, set it aside to evaporate spontaneously, that the *narcotine* may crystallise. When dry it may be tested with a drop or so of a solution of *perchloride of iron*, which produces no blue or green colour. *Sulphuric acid* produces a yellow colour, which becomes *blood-red* on the addition of *nitrate of potash*. The residue in the phial, after pouring off the *ether*, may now be agitated with *acetic ether* to extract the *morphia*. After standing some time, filter off the acetic ethereal liquid, and evaporate in a glass dish over a water bath to a *syrupy extract*; on cooling, the *morphia* will crystallise out in large *radiated striae*, but tinged with a little colouring matter. Treat this with a very little solution of *carbonate of ammonia*, when it will *dissolve*; filter, if necessary, and add a few drops of *acetic acid*, and then a little *ammonia* to *slight excess*, and stir *briskly* with a glass rod, when, if a *milkiness* appears, crystals of *morphia* will be precipitated, and may be recognised by taking up a drop of the liquor in a pipette: on transferring it to a glass slide place it under the microscope, the peculiar *stellar-like* crystals will then be plainly visible.

Fig. 9.



Test a little of the washed precipitate with a drop or so of *perchloride of iron*, which at first imparts a *deep*

blue colour, and on diffusing it through the perchloric solution a *deep sea-green* is produced.

A little of the dry precipitate on a porcelain plate, touched with nitric acid, gives the peculiar *orange-red colour* of morphia.

It is worthy of remark that the crystals of *morphia* obtained by the evaporation of acetic ether become dissolved in a *solution of carbonate of ammonia*, contrary to what is generally observed and stated in chemical works, so that possibly this explains *why* oftentimes no *morphia* is said to be present. I have on several occasions known *morphia* to become gradually *used up* and disappear by washings with neutral or carbonated alkaline liquors. Evaporation to *dryness* and subsequent digestion of the saline residue in hot absolute *alcohol* or cold *acetic ether* will, however, always enable one to extract any *morphia* which may have become so used up or dissolved away that no *morphia need ever be lost*. The same rule will also apply to *any other alkaloid* not readily susceptible of *decomposition* by heat and caustic alkalis.

ON POISONING BY NUX VOMICA.

This substance has sometimes proved fatal when it has been taken either by design or accidentally. The poisonous principles contained in it are *strychnia* and *brucia*; but it is very questionable if either can be extracted from the *contents of the stomach*, owing to the comparatively large quantity of the powder required to produce sufficient of the alkaloids for an experiment. The effects of the powdered nux vomica on the animal organism are *precisely the same* (only in a *less degree*, depending on the quantity taken) as those produced by the *pure poisons strychnia* and *brucia*, viz. tetanic or spasmodic convulsions, rigidity of the muscles, &c., producing what is called 'Opisthotonus.'

If any portion of the powder be found in a packet or vessel from which it had been taken, the following *preliminary* tests may be made upon it.

The powder is of a light grey brown and *very bitter* to the taste.

1. A little of it rubbed up with *liquor potassæ* affords a *rich golden* or gamboge-yellow colour (No. 13) derived from the action of the alkali on the *cortex* of the powdered nut, which is very *characteristic*.

2. A little of the powder in a moistened state, examined by the *microscope* with a quarter-inch lens, plainly shows the *hairy tubes* and filaments of the external envelope.

Extraction of the Active Principles.

In order to accomplish this, we first digest the powder (not less than twenty or thirty grains of it) in *cold* water acidulated with *acetic acid* for about five or six hours, decanting as much as possible of the clear liquor, and again digesting the residue with more water and *acetic acid* for a short time. Filter, mix the liquors, and evaporate to a *small bulk*; then add a few drops more acid, and neutralise with *caustic potash* to a *slight excess*; this will precipitate the alkaloids. Agitate this muddy yellow liquor in a phial, with two or three times its bulk of *ether*; decant the supernatant ethereal solution *carefully* into a sufficiently capacious watch-glass or capsule, and evaporate it spontaneously in the air or over hot water, when crystals of *strychnia* *nearly free* from *brucia* are obtained. This crystalline residue of the ethereal extract, drenched with *strong sulphuric acid*, will perhaps cause a slight *rose-coloured* dis-

coloration on account of the *brucia* it contains, but *will not interfere* with the addition of a small quantity of powdered *peroxide of manganese* dropped in from the point of a penknife, which gives, on *tilting* the white ware vessel or watch-glass placed on white paper, the characteristic *purple colour* of *strychnia* (No. 6 plate). The alkaline liquor left after extracting the *strychnia* may now be agitated with *chloroform* to dissolve out the *brucia*; or, instead of using *ether* to extract the *strychnia*, both alkaloids may be separated at once by using *chloroform*, and, on evaporation to dryness, the *brucia* is easily separated from the *strychnia* by cold *absolute alcohol*, in which *strychnia* is insoluble.

Or the alkaline liquor may be agitated with either *amylic alcohol* (*fusel oil*) or *benzole*, both of which, being lighter than *chloroform*, *float* like *ether* on the aqueous fluid, and can be decanted or drawn off by a pipette, and transferred to a watch-glass for evaporation to dryness.

The *strychnia* is by far the *most predominating* alkaloid, and crystallises out well, the yield of *brucia* being very small. They are readily distinguished in their solution in *sulphuric acid* by the characters already mentioned (pages 10 and 11).

OTHER PHYSICAL PROPERTIES OF THE ALKALOIDS.

Although what has been already stated is, for all practical purposes, quite sufficient for the identification of the vegetable poisons, I here append a few further particulars of some of their chief physical properties which it may be desirable to know.

STRYCHNIA.

A white crystalline substance, scarcely soluble in water, but readily so in *alcohol*, particularly if heated; less soluble in *ether*, but more so in *chloroform*, which takes up 20 per cent. It forms neutral salts with acids, and is precipitated from their solution by an excess of the caustic or carbonated alkalis, in which it is insoluble.

Fig. 10.

1. *Carbonate of ammonia* precipitates it in the form of long spiculæ, thus—when viewed under the microscope.

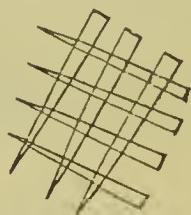


Fig. 11.

2. *Sulphocyanide of potassium* precipitates it in long flattened prisms, thus—the crystals treated with nitric acid produce a clear wine colour which soon disappears.

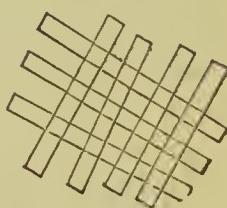
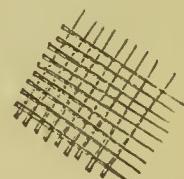


Fig. 12.

3. *Iodide of potassium* precipitates it in fine white needle prisms, thus—



4. *Chloride of platinum* precipitates it in small yellow stellar-shaped crystals, which polarise well, thus—

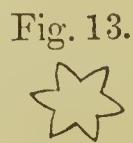


Fig. 13.

5. *Chloride of gold* also produces a yellow crystalline precipitate, and on boiling, the liquor assumes a deep blue or purple colour (No. 6 plate), and fine rings of reduced gold form.

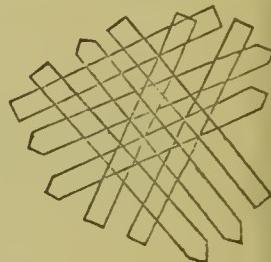
6. *Bichromate of potash*. A few drops of a solution of *acetate of strychnia* briskly agitated with a

drop or so of this agent produce numerous fine yellow crystals, thus (Fig. 14) ; the *merest particle* transferred by means of a pipette to a white ware dish, and touched with *sulphuric acid*, striking a deep violet or purple colour (No. 6 plate), as shown by the author at the British Association, 1856.

7. *Red prussiate of potash* produces also an abundant crop of small pale yellow crystals, thus (Fig. 15) , which likewise give a violet colour (No. 6 plate) with *sulphuric acid*, the colour being the result of the *oxygen* of the agents used.

Fig. 16.

8. *Nitrate of silver* forms with *strychnia* long flat white crystals with square and oblique terminals, thus—

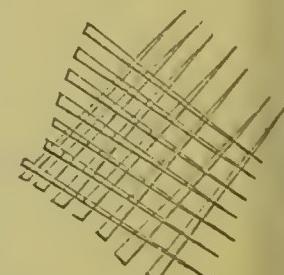


9. *Chlorine water* produces with *strychnia* solution a peculiarly insoluble white precipitate (No. 5), whilst the same reagent strikes a deep red colour with *brucia*.

BRUCIA.

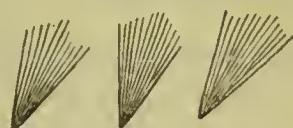
A white substance in silky crystals, which is readily soluble in *alcohol*, but not at all in *ether*, whilst *chloroform* takes up nearly 60 per cent. Very soluble in dilute acids. The solutions of its salts are precipitated by alkalis in longer spiculæ and more slender in shape than *strychnia*, running the whole length of the object-glass, thus —

Fig. 17.



1. *Sulphocyanide of potassium* precipitates it in the form of stellar-like tufts, which dissolve in nitric acid, producing a blood-red colour.

Fig. 18.



2. *Iodide of potassium* precipitates it in very fine needle-like tufts, thus—

Fig. 19.



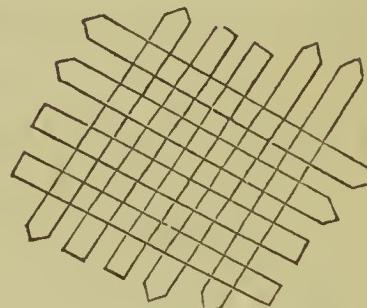
3. *Red prussiate of potash* forms whitish-yellow crystals in wiry or hairy tufts, thus—



4. *Chloride of platinum* produces an abundant yellow amorphous or uncristalline precipitate (No. 17 plate) differing from *strychnia*.

5. *Chloride of gold* produces a dirty-yellow precipitate, turning orange-red (No. 8 plate) on being heated, with a reduction of fine gold.

Fig. 20.



6. *Nitrate of silver* produces after a while remarkably long flat white crystals, more so than *strychnia*, which cover the whole field of view, thus—

7. *Bichromate of potash* produces a copious yellow crystalline precipitate, which, unlike *strychnia*, does not strike a violet colour with *sulphuric acid*; by this it is distinguished.

8. *Nitric acid*.—This agent applied to solid *brucia*, turns it of an orange-red (No. 7 plate), changing yellow.

MORPHIA

May be of an amorphous or crystalline character. It is insoluble in water, but soluble in hot *alcohol*, nearly

insoluble in ether or chloroform, but more soluble in acetic ether. 1. It is turned deep red by cold nitric acid (No. 4 plate), but not discoloured by cold sulphuric acid; nearly insoluble in ammonia, but *freely soluble* in caustic potash or soda. 2. Carbonate of am-

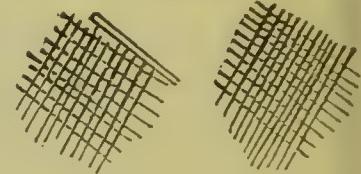
Fig. 21.



monia precipitates it from its pure solutions in peculiar shaped crystals as above.

Fig. 22.

3. *Iodide of potassium* precipitates it after a time in white silky masses, thus —



4. *Iodic acid* and *starch* produce a blue colour, smelling strongly of free *iodine* (No. 3 plate).

5. *Chloride of platinum*.—A copious yellow amorphous precipitate forms (No. 17 plate) with this agent.

6. *Chloride of gold* forms a yellow precipitate, going through different shades of *green* and *purple*, and ultimately reducing the gold.

7. *Perchloride of iron* produces with the solid a *deep blue colour* (No. 2 coloured plate), which on being stirred up dissolves, and changes to a *deep green*.

8. A warm acetic solution mixed with a few drops of *nitrate of silver* reduces it to a *metallic state*, and on filtering the liquor the *blood red colour* of morphia (No. 4) is developed by the addition of *nitric acid*. (Horsley.)

ACONITINA.

In its pure state, it is of a white silky and crystalline nature, insoluble in water, but freely so in *alcohol*, *ether*, or *chloroform*.

Test 1. *Cold nitric or sulphuric acid* applied to the solid produces *no reaction*, but if heated with the latter acid, it produces a brown colour (No. 11 plate).

2. The *caustic alkalis* produce, with its solutions, a *white precipitate*, which is *redissolved* on the addition of more water, by which it is distinguished from *atropia*.

3. *Chloride of gold* produces an *ABUNDANT yellow amorphous precipitate* (No. 17 plate).

4. *Chloride of platinum* produces *NO PRECIPITATE* with this alkaloid, which is characteristic.

ATROPIA.

When pure, it is of a white, silky, and crystalline nature, insoluble in water, but freely so in *alcohol*, *ether*, or *chloroform*, particularly the latter, to 50 per cent.

Test 1. *Cold nitric or sulphuric acid* produces *no reaction*; but, if *heated* with the latter, a pinkish colour is produced (No. 16 plate). It is *not*, like *aconitina*, *precipitated by caustic alkalis*.

2. *Chloride of gold*.—This agent forms with its solutions a yellowish white *amorphous precipitate*, which afterwards becomes *crystallised* in the form of large rhomboidal plates, like *nitrate of urea*, if viewed by a microscope (No. 17 plate), which also distinguishes it from *aconitina*. (Horsley.)

3. *Chloride of platinum* produces a precipitate which is *curdy* and pale yellow (No. 17 coloured plate).

VERATRIA.

An amorphous light brown powder, of a hot acrid taste, insoluble in water, tolerably soluble in alcohol and ether, but more so in chloroform, to nearly 60 per cent. Its acid solutions do *not crystallize*, nor are they precipitated by caustic alkalis, like *strychnia*, *brucia*, &c. from being more soluble than those alkaloids.

Test 1. *Cold sulphuric acid* applied to the solid turns it of a *deep orange yellow*, which on *being warmed* is changed to a *carmine colour* (No. 9).

2. An acetic solution treated with *chloride of tin*, and evaporated to dryness, becomes of a *blood red colour*. (No. 9.) (Horsley.)

3. An acetic solution mixed with its bulk of strong *sulphuric acid*, also produces a *blood red colour*.

4. *Chloride of platinum* produces a *slight yellow precipitate*.

5. *Chloride of gold* forms an *abundant yellow* (No. 13) precipitate, soluble on boiling, with a reduction of pure gold.

NICOTINA.

Very soluble in water, *alcohol*, *ether*, or *chloroform*, leaving the oil as a residue, on evaporation, which is *alkaline* to test paper. The oily residue, on being warmed or heated *per se*, gives off the peculiar fumes of tobacco smoke of a very irritating character.

1. *Bichromate of potash* produces with it a yellow crystalline precipitate (No. 13 plate).

2. *Red prussiate of potash* produces with it a yellowish white precipitate (No. 17 plate).

3. *Chloride of platinum* produces with it an orange yellow, or red crystalline precipitate (No. 8 plate).

4. *Chlorine* produces with it a *blood red* liquid (No. 4 plate).

CONIA.

Like *nicotine*, this is an oily alkaloid, and evolves a peculiar powerful odour of hemlock or mice. It is very soluble in *alcohol*, *ether*, or *chloroform*, leaving the oil behind on evaporation. Its solutions are not precipitated by *alkalis*. We have no particular test for it. Unlike *nicotina* it is *not soluble in water*.

PICROTOXIA.

In its pure state it is a white crystalline substance, very *bitter* to the taste. It is *very soluble in water*, particularly hot, and not precipitated by *alkalis*. Being destitute of nitrogen, it does not come under the denomination of an alkaloid (as *strychnia*, for instance), but is the peculiar bitter principle of *Coccus Indicus*, analogous to *salicine*, the bitter principle of willow bark. It differs, however, from *salicine* by several characters.

1st. It is highly poisonous, which *salicine* is not.

2nd. It is turned yellow-brown by cold *sulphuric acid*, and dark brown by the hot acid (No. 11 plate), whereas *salicine* becomes of a pink colour (No. 16 plate), when touched with *sulphuric acid*, which is *intensified by heat*, and grows syrupy.

3rd. The microscopic appearance of the crystals of *picrotoxia* is unmistakable. See page 21.

COLCHICINA.

This alkaloid is obtained from the bulbs, flowers, and seeds of *colchicum autumnale*. It is in the form of colourless needles, which are soluble in water, alcohol, and ether, is of a bitter taste, and very poisonous. $\frac{1}{10}$ of a grain killed a cat in twelve hours. In very small doses it produces violent purging and vomiting.

1. *Nitric acid* renders it *dark violet or blue*, which is most characteristic.
2. *Sulphuric acid* turns it *brown*.
3. *Bichloride of platinum* gives with it a *yellow precipitate*.

It is rarely met with in a pure state.

DATURIA.

This substance is obtained from the seeds of *Daturia stramonium* (thorn-apple). It crystallises in colourless quadrangular prisms, soluble in water and alcohol, and is precipitated from its solutions by *alkalis*, as a white powder. It is of an acrid bitter taste and very poisonous. $\frac{1}{8}$ of a grain killed a sparrow in three hours. Its effects are analogous to those of *atropia* and *hyoscyamia*. When applied to the eye it dilates the pupil very considerably, the effect lasting for several days. This poison, like the preceding, is rarely met with.

DIGITALIA.

This is obtained from *digitalis purpurea* (foxglove). It is in the form of a white powder of a very bitter

taste, having an alkaline reaction. It is very poisonous; $\frac{1}{16}$ of a grain probably killing an adult.

1. *Hydrochloric acid* produces a yellow colour, speedily changing to *green*.

2. *Sulphuric acid* turns it brown, and red, but the addition of water forms a *dirty green*.

Grandreau extracted it by dialysis from mixed organic matters.

3. A dilute solution of it evaporated to dryness, and moistened with *sulphuric acid*, gives a *rose* colour which, on exposure to the vapour of *bromine*, turns to a *violet* or *mauve colour*, which Grandreau says is very characteristic, as no other substance is similarly acted on.

It is rarely met with, although a case of poisoning by it formed, not long since, one of the *causes célèbres* of France.

HYOSCYAMIA.

This substance is obtained from henbane (*hyoscyamus niger*). It is in the form of silky crystals, not easily soluble in water, but readily so in *alcohol* and *ether*. It has an acrid taste, and an odour resembling tobacco, and is very poisonous, $\frac{1}{10}$ of a grain having a powerful effect on the system. Its solution, when applied to the eye, dilates the pupil considerably. There are no satisfactory means of recognising it with chemical tests.

Sulphuric acid turns it brown.

It is rarely met with in its pure form, and is very difficult to obtain, from its great proneness to become *decomposed*.

SOLANIA.

This alkaloid is obtained from either the black berries of the garden nightshade (*Solanum nigrum*) or the red berries and leaves of woody nightshade or bitter sweet (*Solanum dulcamara*), or from the fruit and leaves of the potato (*Solanum tuberosum*). It is in the form of a crystalline powder, of a nauseous, bitter, and acrid taste. It is sparingly soluble in water, but readily so in alcohol, and very poisonous. One grain killed a rabbit, producing paralysis and death in six hours. It does not dilate the pupil, nor produce stupor and delirium, like *atropia*, *daturia*, or *hyoscyamia*.

1. *Chromic acid* gives with it a *sky blue* colour, changing to *green*.
2. *Sulphuric acid* yields an *orange-red* colour, changing to *violet*.
3. *Nitric acid* with vapour of *ammonia* produces a *rose red* colour.

PHENYLIA OR ANILINE.

For particulars of this alkaloid, now so extensively used in the production of the beautiful coal-tar colours or dyes, see the article *Nitro-Benzole*.

If to the *purified extract* of any vegetable substance a small quantity of freshly precipitated *iodide of mercury* dissolved in an aqueous solution of *iodide of potassium* be added, and a *precipitate forms*, it is a sure sign of the existence of an alkaloid of *some sort*. (The liquid to be treated must be free from *albumen*.) The solution of *hydrargyro-iodide* is easily made by dissolving 4 grs. or so of *bichloride of mercury* in an ounce of distilled water, and adding 15 grs. or so of *iodide of potassium*, till the *reddish precipitate* first formed is *dissolved* and a *clear solution* obtained.

NITRO-BENZOLE OR ESSENCE OF MIRBANE.

This substance, now so much used for scenting soaps and pomades, strongly resembles *essential oil of almonds* in appearance and flavour, and from its not containing *prussic acid* was, at one time, not considered poisonous. It is made by acting on *benzole* (one of the derivatives of coal-tar) with *nitric acid* and heat, then washing the oily fluid with water. *Essence of mirbane* is distinguished from *essential oil of almonds* by the action of *sulphuric acid*, which discolours the latter *blood red*, but is without action on *nitro-benzole*.

Its poisonous properties depend on *aniline*, which it is capable of being converted into by the animal organism. Dr. Letheby was the first to call attention to this substance as a poison, from several cases which had come under his observation, and it is to that gentleman the following notice of its effects, and the method of its elimination and identification, is due. He considers *nitro-benzole* to be a *powerful narcotic poison*, attended, when taken internally or even inhaled, with drowsiness, convulsions, and coma. *Several days* may sometimes elapse before its fatal termination. When death is rapid the smell of *nitro-benzole* is perceptible in every tissue of the body, but in lingering cases *no smell* is observable, it having been converted into *aniline*, the colouring effects of which (purple and mauve) are sometimes recognised in the skin, gums, lips, and nails. To extract the poison Dr. Letheby suggests the matters to be bruised in a mortar, with a little distilled water, acidulated with *sulphuric acid*, and then distilled from a retort. *Nitro-benzole* passes

over into the receiver unchanged, and can be detected by the *bitter-almond like smell*; the residue in the retort is treated with strong *alcohol* to extract the *sulphate of aniline*; the alcoholic solution is treated with *acetate of lead* to precipitate organic matter, and the excess of lead thrown out by *sulphate of soda*: the filtered solution is next treated with *caustic potash* and distilled to *dryness* in an oil-bath. The distillate contains the *aniline*, which is detected by the nascent oxygen of a galvanic battery, thus:—A drop or so of the solution of *aniline* in 1000 of dilute *sulphuric acid* (1 to 7 of water) is placed on a clean piece of platinum foil, and touched with the negative pole of a galvanic battery (a single Grove's cell), whilst the positive pole is in contact with the platinum plate—the liquid instantly acquires a *bluish*, then *violet* colour, changing to pink, the colour being more intense when the *aniline* solution is stronger.

In a similar manner, Dr. Lethby observes that analogous coloured reactions may be obtained from *strychnia*, which, however, is distinguished from *aniline* by the volatility of the latter and its capability of distillation.

Although the neutral salts of *aniline* are not considered poisonous, from the fact of so much as an ounce of the *sulphate* having been taken without any apparent injurious effect, yet the crude *aniline* is eminently so. *Aniline*, formerly obtained from indigo, is now generally made from *nitro-benzole* by distillation along with *acetic acid* and iron filings, and, when pure, is a colourless oily liquid, devoid of oxygen,

and possessing a strong disagreeable odour and a hot aromatic flavour, forming salts with acids.

Nitric acid added to pure *aniline* produces a *blue* colour, and a solution of *chloride of lime* gives a beautiful *violet blue* colour, turning *red* on the addition of an acid, which is characteristic of *aniline*; indeed, all the various colours produced with *aniline* are the result of superadded oxygen in some form.

ON POISONING BY PHOSPHORUS.

If a *distinct smell* of *phosphorus* be recognised in the contents of the stomach, intestines, or even the food partaken of, these should be washed in a vessel of water, the liquid decanted as dry as possible, and search made for any *white particles* supposed to be *phosphorus*. These, or the contents, being *moderately heated* on a small iron dish in the *dark*, will give out a white smoke and *luminous flames* indicative of the presence of *free phosphorus*.

This being the case, another portion of the contents may be digested by agitation in a bottle containing some *bisulphide of carbon*, when the *phosphorus* readily dissolves, and, on *spontaneous evaporation* in a glass basin, it is obtained in *small globules or beads*, which sometimes take fire of themselves, burning in the dark with a yellow flame. The solid particles should be preserved in water.

Another portion of the contents may be boiled with diluted *nitric acid*, and the liquid filtered, carefully neutralised with soda, evaporated to dryness, and the residue *incinerated* in a Berlin crucible, when the *phosphorus* will have been converted into *pyrophosphoric acid*, or

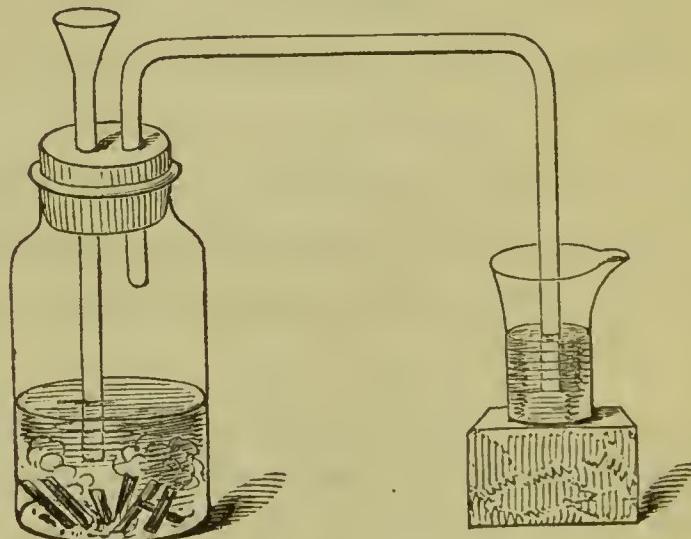
rather pyrophosphate of soda, a solution of which in boiling distilled water and filtered, is fit for testing, and even estimation, as follow:

Test 1. Ordinary phosphoric acid yields with a solution of nitrate of silver a yellow precipitate, but the ignited acid, as in this case, gives a white precipitate (No. 5 plate) of pyrophosphate of silver, 10 grs. = 2·36 gr. phosphoric acid.

2. Another portion of the solution of pyrophosphate of soda, mixed with ammonia and then a little sulphate of magnesia—a white precipitate of pyrophosphate of magnesia forms 10 grs. = 6·42 phosphoric acid.

Should there be no smell of free phosphorus, it may possibly have been converted in the system into phosphoric acid. In that case, a simple digestion of the contents in hot water may extract the acid, and, on evaporation of the liquid to dryness, the silver and magnesia tests, just mentioned, may be applied to its solution.

Fig. 23.



3. Or 'phosphoretted hydrogen' may be generated thus:—into a bottle, proper for making gas, introduce

the suspected liquid, together with some diluted *sulphuric acid* and zinc, and pass the gas through a solution of *nitrate of silver*. A dark precipitate of ‘*phosphide of silver*’ forms, which should be collected on a filter, well washed, dissolved in a little *hot nitric acid*, and the solution evaporated to dryness; then boiled with *liquor potassæ* which *abstracts the phosphoric acid*, and the *oxide of silver* is precipitated. The alkaline liquid being filtered and carefully neutralised with *acetic acid*, the addition of *nitrate of silver* to a portion of it yields a characteristic *yellow precipitate* (No. 17 plate) of *phosphate of silver* soluble in *ammonia*, and capable of *reproducing* the *yellow phosphate* by the addition of *acetic acid*, by which the *phosphorus* can be demonstrated.

10 grs. of *yellow phosphate of silver* are equal to 1.71 grs. of *phosphoric acid*.

4. Or, another portion of the aceto-phosphatic solution of *potash* may be tested with a few drops of a solution of *perchloride of iron*, when a ‘whitish precipitate’ of the *phosphate of peroxide of iron* is produced, which is *browned* on the addition of a little *ammonia*, and quite *insoluble* in *acetic acid*. This also is very characteristic of *phosphoric acid*.

5. Or, another portion of the phosphatic solution of *potash* may be mixed with a little solution of *sulphate of magnesia*, and *free ammonia* added; when, on *briskly stirring* it with a glass rod, a *crystalline precipitate* of *ammonio-phosphate of magnesia* forms.

Phosphorus, although a very dangerous substance, is not often had recourse to for poisoning purposes, but we frequently hear of children having been poisoned from sucking the ends of matches which have been

coated with *phosphorus*, and also a few instances where what is called phosphor paste, used for poisoning rats and mice, has been taken. Phosphor paste, being composed of *phosphorus* melted with lard and mixed with flour, the *phosphorus* can be easily dissolved out by *bisulphide of carbon*, and treated for testing as before mentioned.

As *phosphorus* in some form or another enters into the composition of the human body, allowance must be made in calculating the amount of *phosphoric acid* obtained in an analysis.

ON MINERAL ACIDS.

As *sulphuric*, *hydrochloric*, or *nitric acid*, is seldom used for poisoning purposes, I have not thought it necessary to allude to them, since their effect on the organism is sufficiently obvious, and their detection easy; but instances have been known where one or other of them had been used with a malicious intent to injure or destroy the person or clothes of a party: such a case will present no difficulty in the hands of a practical man.

ON THE SEPARATION OF POISONS BY DIALYSIS.

The excellent invention of Professor Graham, known as *dialysis*, may sometimes be used with advantage for the separation of poisons from organic matters. It is, however, somewhat tedious, and only adapted for *qualitative* purposes. The poison (metallic or vegetable alkaloidal) is separated for the most part freer from contamination by animal matter than in the ordinary way. The apparatus to be used consists of a circular

band of gutta percha, over which a piece of wetted parchment-paper or bladder is strained, which is kept *in situ* by another ring, one of 4-inch diameter will suffice. The contents of the stomach, or the sliced organic matter, being placed on the diaphragm, is covered with water acidulated with *hydrochloric* or *acetic acid*, and the vessel floated over a body of distilled water contained in an outer glass, dish, or pan, and left for twenty-four or forty-eight hours, occasionally changing the water.

The *mixed diffusates* are then carefully evaporated to dryness, and the residue examined in the usual way for poison. If metallic, by digestion in *hydrochloric acid*; and, if alkaloidal, precipitated by an alkali and again taken up with *ether*, *chloroform*, &c.

In the case of insoluble metallic compounds, with albuminoid matter, it will be necessary to boil the organic matter in dilute *hydrochloric acid*, and let it cool before proceeding to dialyse.

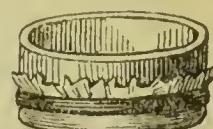
The author has succeeded in separating various metallic and vegetable poisons by this process. Aqueous or acid solutions only should be dialysed.*

ON BLOOD SPOTS.

As the Examination of Blood is often a subject of inquiry, a chapter thereon may not be out of place.

The corpuscles of man, the monkey, dog, horse, ox, sheep, pig, hare, &c., are very similar in form, and

* Gutta percha rings and prepared parchment may be obtained of Griffin, 119 Bunhill Row, London.



consist of little round yellow discs with a slight central depression. To a person not very well acquainted with their microscopic characters, they would at first sight appear to present little difference except in size, those of man being *certainly larger*; but without an actual comparison being simultaneously made with a known slide of human blood, there would be some difficulty in pronouncing an opinion as to their difference. There could, however, be no such difficulty with the blood of fishes, birds, &c., as their corpuscles are not only very much larger, but are of a long lozenge or ovoidal shape, with a ring or nucleus in the centre instead of a depression as in those of mammalia.

These blood corpuscles are best examined by moistening the spot with a drop or two of some fluid heavier than water, as fresh urine, white of egg, or a saturated solution of *sulphate of soda* slightly alkaliised with *caustic soda*, as suggested by Lesueur and Robin; after some little time has elapsed the globules begin to swell, and can be viewed through a microscope having a $\frac{1}{4}$ -inch lens, and will appear as little globules like oil floating on the surface of the liquid, some being single and others united. They are best seen by the light of a candle, and easily distinguished from the fibrinous and albuminoid matter.

A chemical examination may also be made by immersing or suspending a piece of the spotted clothes in a vessel of water, when the red coloured extract of blood will fall in streaks. This solution must be divided into several portions for some of the following experiments:—

1st. One portion of the red aqueous solution may be treated with a little *ammonia*, which should not produce any alteration or increase of colour from that of red, but simply render the liquid brighter.

2nd. Another portion of the aqueous solution may be boiled to effect a coagulation of the albumen it contains. The dirty red coagulum obtained, when dissolved by boiling with a little *caustic potash*, forms a solution which is green by transmitted light, but red by reflected light.

3rd. Another portion may be treated with its bulk of alcohol, which precipitates the albumen completely on the test tube being immersed in hot water, the coagulum being of a red colour.

4th. Another portion treated with *chlorine water* has its colour destroyed, and on being heated a flocculent white precipitate forms.

5th. Another portion may be treated with a grain or two of *yellow prussiate of potash*, and then a drop or so of *acetic acid* added, when a brown curdy precipitate forms.

6th. Another portion treated with a drop or two of *nitric acid* produces a whitish precipitate, at first, turning brown on agitation.

7th. Another portion of the aqueous solution of the dried blood in a test glass should be treated with a grain or two of *bichloride of mercury*, and well stirred up. In about two or three hours it will have become a firm *red coloured jelly*, which no vegetable colouring matter or extract will produce.

So far this proves the existence of albumen ; we have now to prove the existence of the *iron*.

Incinerate a portion of the dried blood, and observe if the odour of animal matter is evolved ; any *ammonia* is detected by moistened turmeric paper : next dissolve the residue in a little *hydrochloric acid*, and test for *iron* by *yellow prussiate of potash*, which gives a *blue* or bluish-green colour if the quantity be small ; *sulpho-cyanide of potassium* or *ammonium* produces a *deep red* colour.

If an instrument bearing red spots on it has to be tested for blood, one portion of the dried spot should be treated as described for viewing the blood corpuscles. A second portion, digested in cold water and filtered from any *iron rust*, should be tested for albumen ; whilst a third portion should be incinerated for the detection of the animal odour, and subsequent extraction of the iron.

Any *human hairs*, either on the instruments or mixed up with the dried blood, should not be overlooked.

ON TRACES OF POISON.

At page 11, under head of 'Strychnia,' I have stated that by very careful manipulation $\frac{1}{100000}$ part of a grain may be detected : of course this is understood as applying to the *pure* poison (free from organic matter) ; but experiments made subsequently show that I have not *over-estimated* it, as a much less quantity may be readily detected, and as some persons may be interested to know how such 'infinitesimal quantities' can be demonstrated, I subjoin the following experiments in proof.

First make a solution of one grain of pure crystallised *strychnia* by reducing it to a fine powder in a small glass

mortar, then adding four drops of *acetic acid* and triturating with 96 drops of distilled water till dissolved, every drop being equal to $\frac{1}{100}$ of a grain. Now make a 'fractional standard solution' by mixing one drop with 999 drops of water, adding from the point of a penknife about half a grain or so of powdered *red prussiate of potash*.

Project one drop of this standard solution into a *very small* porcelain capsule and evaporate it to dryness over the *gentle* heat of a water-bath; when cold, by drawing a *small pointed* glass rod wetted with *colourless sulphuric acid* in three several places *across the dried yellow spot*, a well-marked *purple* or violet colour will be developed, changing to pink, which is visible for several hours: therefore these marks either singly or collectively clearly prove the possibility of detecting so small a quantity as $\frac{1}{300000}$ part of a grain of strychnia. *Bichromate of potash* is much less sensitive than *red prussiate*, for by the same process the utmost the author could detect with bichromate was $\frac{1}{10000}$.

Fractional standard solution of strychnia for comparative testing.

1 drop ($\frac{1}{100}$ of a grain) + 999 of water with red prussiate of potash.

1	drop evaporated to dryness equal to	$\frac{1}{100000}$	grain.
2	"	$\frac{1}{50000}$	"
3	"	$\frac{1}{33300}$	"
4	"	$\frac{1}{25000}$	"
5	"	$\frac{1}{20000}$	"

and so on; the various shades brought out by *sulphuric acid* becoming more and more striking as the number of

drops are *increased*. Even $\frac{1}{5000}$ part, *deep* as the colour is, can only be estimated by a similar chemical method.

From this it follows that what is technically called a trace (which many persons are in the habit of ignoring as unreliable), may by comparison be *approximatively* estimated or measured, so to speak; the practised eye being a much better judge of *quantity*, by the intensity of shade produced, than the most accurate balance is of weight. The same rule may also be applied to many other kinds of poison.

If therefore the expression *large or small traces* be not admissible as *evidence of the senses*, of what use is the principle of testing? for if ever so small a quantity of a foreign and poisonous substance be *clearly established* as having been extracted from a *dead body*, the presumption is that *more* of it had been taken or administered. In no case do we ever expect to recover *all*, it being well known that many instances have occurred of persons having died from the effects of poison of some kind without any being found, or at most but *mere traces*, owing to the major portion having, during the life of the individual, been either *decomposed in the organism* or eliminated from the system by one or other of the natural outlets of the body.

The decision as to the *cause* of death is therefore referred to the *physiologist*; but, if the chemical evidence is *fully borne out* by the physiological, and *vice versa*, the case will be rendered the more demonstrable. Death from poison seldom or never takes place without the presence of some premonitory symptoms, *indicative of the nature* of the agent used; the analyst being informed of these symptoms, will then

be enabled to direct his *special attention* accordingly. The poison being found, it will be still more conclusive if a *similar kind* be traced to the possession of the accused.

EXTEMPORANEOUS PREPARATION OF CERTAIN REAGENTS MENTIONED IN THE PRECEDING PAGES.

SULPHURETTED HYDROGEN.

Put into a gas bottle, fitted with a bent delivery tube, some powdered *bisulphuret of iron*, and pour over it some *sulphuric acid*, diluted with 4 or 5 times its bulk of water, when the gas will commence being evolved; sometimes it is necessary to have it *well washed*, in which case it should be made to pass through an extra bottle of water. By the *coloured precipitate* which *sulphuretted hydrogen* produces with various metallic substances we are enabled to *readily distinguish* one from the other. As before stated, in the case of arsenic, antimony, &c., the solutions should always be rendered ACID before testing with this gas.

SULPHUROUS ACID GAS.

This reagent is often required for *reducing arsenic acid* and its salts to a *lower degree or state of oxidation*, previous to further treatment with *sulphuretted hydrogen*, in order to obtain it as a 'yellow sulphide.' It is readily evolved from *sulphite of soda* by putting some of that salt into a small flask fitted with a bent tube, and pouring over it some diluted *sulphuric* or *hydrochloric acid*, conducting the gas into the liquid. Or in

the event of *sulphite of soda* not being at hand, we may introduce into a flask about $\frac{1}{2}$ oz. of pounded charcoal with 4 or 5 ounces of strong *sulphuric acid*, and applying a gentle heat to the flask, *carbonic acid* and *sulphurous acid* gases are given off, the latter only being retained in solution in the water of the receiver, which should be charged until it smells strongly, and then kept in a stoppered bottle.

CHLORINE WATER.

This is best made by placing in a flask fitted with a bent tube a saturated solution of *chloride of sodium* (common salt) in water, adding about $\frac{1}{6}$ its bulk of *nitric acid*, with some powdered *binoxide of manganese* or *red lead*. On the application of a gentle heat, the gas may be evolved over perfectly pure into a jar of water until it is thoroughly saturated. As the solution is very susceptible of decomposition, it must be kept in a stoppered bottle in the *dark* or surrounded with blue paper. Or *binoxide of manganese* and *hydrochloric acid* may be substituted, applying heat to the flask as before.

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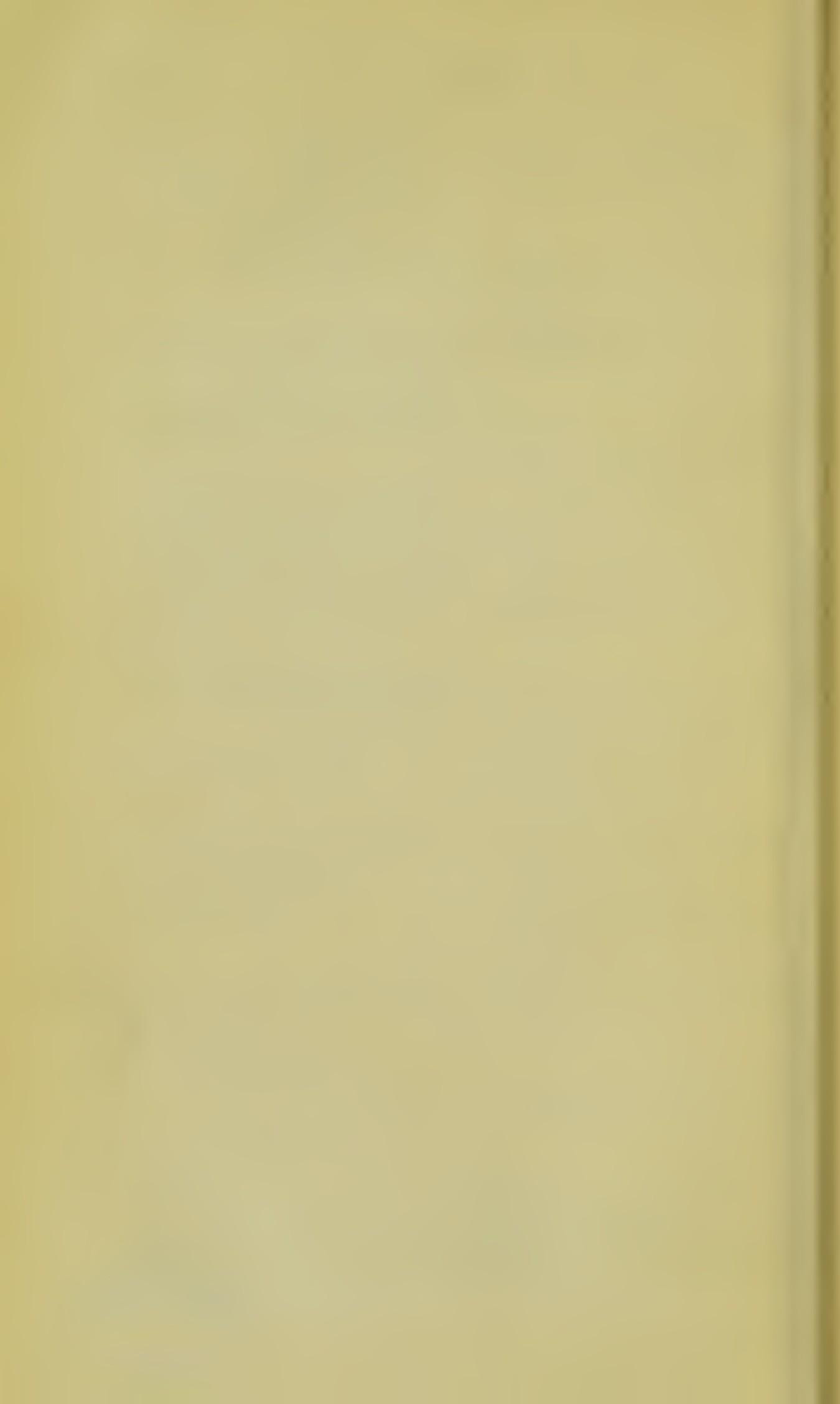
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